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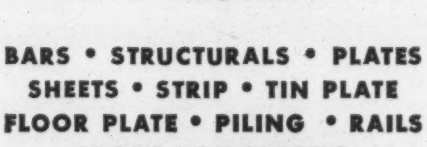

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EDITORIAL

The Spotlight Is on Materials

An examination of the programs being presented before two national societies during the month of June serves to emphasize the increased attention being paid to engineering materials—and materials engineering.

Early this month the Society of Automotive Engineers—one of the most materials minded groups in existence—met in French Lick, Ind. A large part of the program was devoted to round tables. Of 18 round tables scheduled four were on engineering materials. The next most active subject that of the passenger car. In addition, another entire morning was devoted to a symposium on corrosion.

The technical information developed at this meeting is primarily for those engaged in the automotive and aircraft industries. However, the automotive industry has always been generous in passing its know-how on to industry in general. The interest in the engineering materials activity of the SAE is primarily one of materials engineering—how best to select, process and apply materials for the job at hand.

Later this month in Atlantic City another mighty important group holds its annual meeting. Several thousand men will attend the sessions of the American Society for Testing Materials. Here producers of materials, buyers of materials and the ultimate consumer of the product being made of the material will sit down together and try to arrive at satisfactory materials standards.

Although the "materials" covered by the A.S.T.M. include practically any substance sold commercially for conversion into a saleable product or structure, here again a major share of the attention goes to engineering materials—their specifications, their service characteristics, and methods of testing both.

Why all this attention to engineering materials?

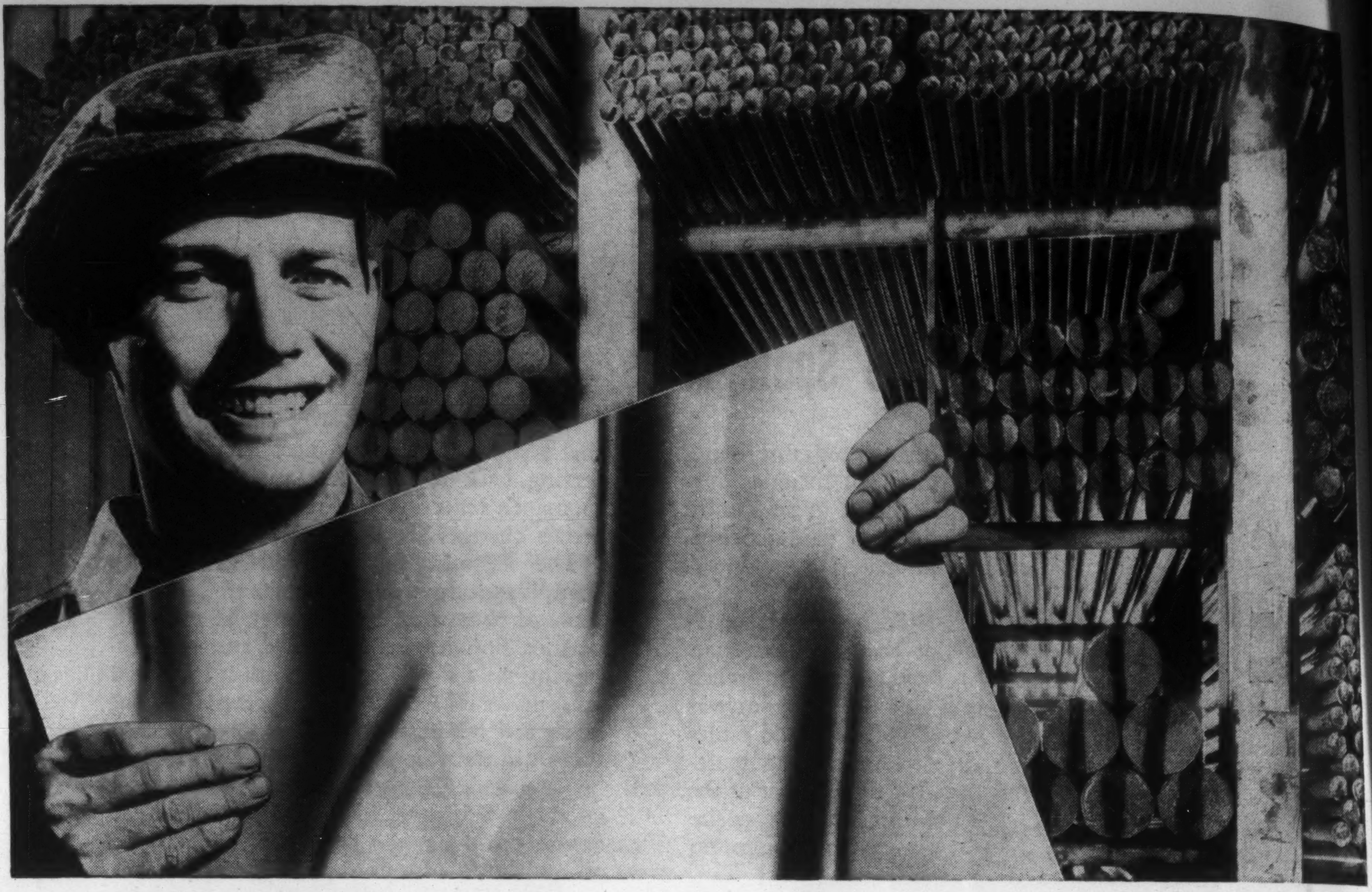
Intelligent, forward-looking industry knows that it must keep studying the materials problem constantly if the products of industry are to keep pace with progress. What was good enough ten years ago may or may not be satisfactory now. Chances are that some modifications must be made. Referring back to the automotive industry, a moment's reflection will remind us that materials changes are being made constantly.

Die castings replace sand castings or stampings for some applications and, in turn, some of these parts might later be made of plastics. Stainless steels or clad steels are replacing mild steel which later must be plated at considerable cost. Special deep drawing steels and other sheet stock is developed so that uniformity in large body stampings can be achieved. Countless examples could be cited in this one industry alone. Similar stories could be told in almost any branch of industry—for example, powder metal parts are used to produce toy trains; nodular irons will probably extend the range of application of gray irons; titanium comes along to compete with stainless steel, some copper alloys and aluminum. Every technical advance along scientific lines brings with it the need for a revision in thinking or new developments in the field of materials engineering.

Our chief purpose on dwelling on this subject is to try to impress anyone who might read this with the fact that there is no reason why any company should be poorly informed on materials. The two societies mentioned, plus the American Society for Metals, American Institute of Mining & Metallurgical Engineers, American Society of Mechanical Engineers, and many industry groups spend countless hours and dollars learning more about materials.

Information developed by these groups becomes readily available through technical publications such as this as well as publications of the Societies, and later in book form. Despite this ready availability of information, there are still many companies that make no attempt to keep abreast of materials developments. When they are finally forced by competition, or by their customers, to provide something better, there ensues a mad scramble for information which wastes time, money and allows no leeway for proper development.

T. C. Du Mond
Editor



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Materials & Methods
JUNE 1949

New method of production involves molding butyl material around component parts under high pressure.

Materials Problems Solved to Develop New Butyl-Molded Transformer

Here is the story of how materials engineering made possible the achievement of long sought after improvements in the production and performance of current transformers.

by I. F. KINNARD,
Manager of Engineering,
Meter & Instrument Div.,
General Electric Co.

● IT HAS LONG been a goal of the electrical manufacturing industry to simplify production of dry-type transformers by finding an insulating material that could be molded or cast around the transformer core and thus eliminate costly and laborious hand wrapping. That goal has now been achieved, at least for instrument type transformers. Largely through painstaking and astute materials engineering, a suitable butyl compound has been developed by the General Electric Co. which makes possible a transformer of unit construction with all component parts firmly molded together in a continuous casing of butyl.

The almost universal method of insulating dry-type transformers has been to wrap a fibrous material, commonly varnished cambric or crepe paper, around the coils and then impregnate this matrix with asphalt or a similar insulating compound. In many designs, as much as one-quarter mile of crepe paper has been wrapped on the coils, and, because of the complex configurations of the coils, most of this wrapping has been done by hand.

The use of butyl insulation not

only eliminates the necessity of this hand wrapping but also results in a distinct improvement in performance characteristics over older designs. Primarily, better insulation which will withstand a wide variety of operating conditions is achieved. Also, a stronger transformer is possible since the one-piece butyl construction holds the parts firmly in position and yet the butyl is resilient enough to absorb the shocks of high momentary overloads and rough handling without cracking. More consistent quality is possible, both in dimensions and insulation characteristics, since the relation of parts is determined by the mold and is not subject to the human errors of hand insulating.

Background of Development

In the search for a suitable insulating material, two principal materials problems or requirements had to be met. First, the material had to be capable of being readily and economically molded or cast about the transformer assembly, giving a solid homogeneous casing without voids. Second, the material had to have performance characteristics equal to or better than those of older materials.

The search began in 1930, when a mixture of portland cement and sand was tried by General Electric engineers. Because it tended to crack after hot and cold temperature cycling, however, this material was not successful. During succeeding years, 28 additional materials were tried with various molding and casting techniques. These included Catalin, asphalt-impregnated portland cement, solventless varnish, phenolic resins with various fillers, silicone rubber, and a host of others. Many individual difficulties were encountered with these materials, but, in general, they tended to crack during temperature cycling, which expanded and contracted the metal parts of the transformer. In addition, they were difficult to mold or cast without voids.

Late in 1945, butyl rubber was tried with promising results. As is well known, butyl is one of a group of synthetic elastomers, a product made from petroleum by reacting two of its derivatives, isobutylene and isoprene, at low temperatures. The engineers found that butyl was flexible enough to withstand extreme dimensional change in the metal parts, and the pressure used in molding gave a dense, homogeneous insulation with no voids. The search for the ideal material was thus narrowed to one basic type.

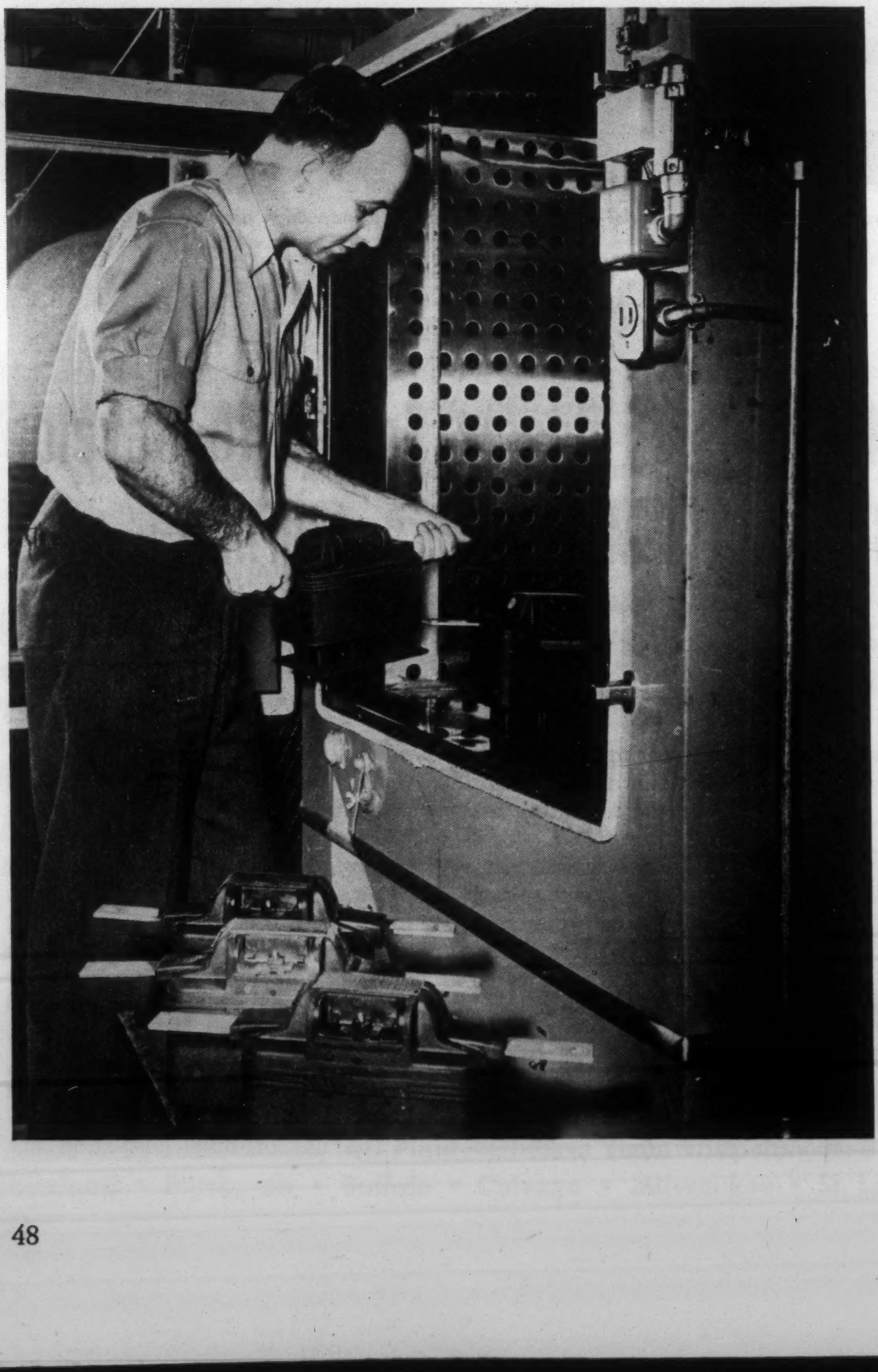
In order to obtain the maximum advantage from this material, however, it was necessary to develop a special butyl compound that would best suit the needs of molded transformer insulation. The Bridgeport Works Laboratory of the General Electric Co. was asked to develop this compound. Several years before, this laboratory had actively participated in the development of a butyl gum expressly designed for electric insulation of power cables. At that time it was learned that this basic material is characterized by a high degree of saturation, which left very few unstable molecules that would tend to combine with oxygen and thus cause a general degradation of the properties of the material. This is particularly important for electric insulation since high temperature and the formation of ozone during corona discharge tend to accelerate the normal oxidation effect and shorten the life of the insulation. These properties, which were originally developed in the material for use as cable insulation are equally well suited for transformer insulation, so this basic gum was selected for transformer use.

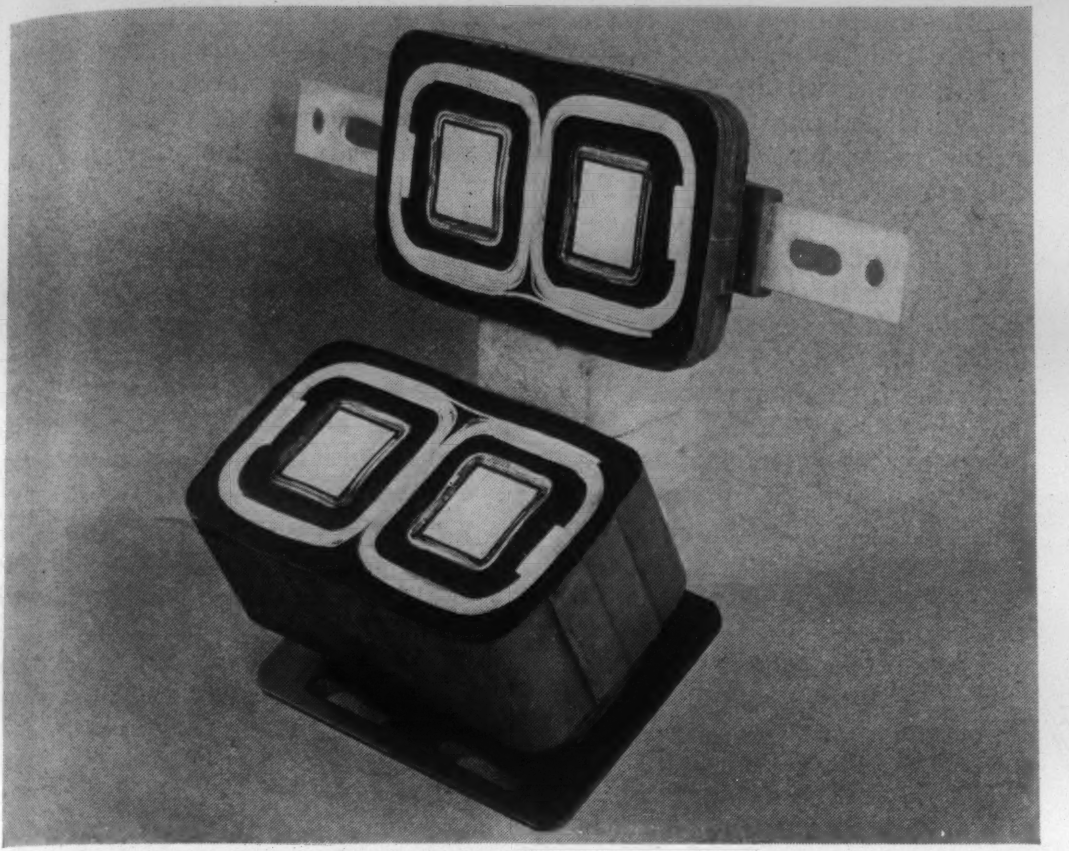
However, less than half of the weight of most butyl compounds consists of butyl gum; the balance is made up of various filler materials, which impart many of the physical and chemical properties that are desirable. The Bridgeport Works Laboratory compounded a number of combinations of filler materials with the basic gum until they obtained one with the required properties.

Technique of Molding

In the molding operation, the core and windings of the transformer are assembled together, baked out com-

The butyl material and completed transformers underwent exhaustive tests before final acceptance. Here a transformer is being put in oven for accelerated life tests.





A cross-section view of the new transformer, showing how all component parts are molded together in a continuous casing of butyl.

pletely, and properly positioned in a hot cast-iron mold. Butyl is injected into the mold under controlled pressure and temperature. When the mold is completely filled, a mechanical shut-off is closed to retain the pressure and the mold is placed between two hot steel plates for curing. After curing, the completed transformer is removed from the mold. Since the nameplate information and the polarity markings are molded directly into the surface of the butyl, the only subsequent operations are to remove the flash, color the nameplate and polarity markings, and attach the secondary terminal hardware and cover. The transformer is then ready for final inspection and test.

During the development stages, many samples were cut apart to determine the condition of the material inside the transformer. Every sample was X-rayed so that the position of the parts could be studied. Complete tests were made to determine the exact quality of the completed samples. While many problems were encountered in developing the molding process, a satisfactory molding technique has been established.

Performance Requirements Met

Before final acceptance of this special butyl compound, exhaustive tests on the butyl itself, and on complete molded transformers were made. From these tests and other critical examinations, the properties of the special butyl compound were found to be ideally suited for the purpose. The accompanying table lists a number of these properties in comparison with the asphalt-paper material.

Mechanical and Physical Properties—The cutting resistance, tear resistance, thermal conductivity, and resistance to abrasion of the butyl selected were all found to be higher than necessary for the application. The tensile strength of 750 psi. is greater than that of older insulations and more than adequate to hold the parts of the transformer firmly together under all conditions of mechanical shock due to electrical overloads or even accidental rough handling. Since it has an elongation of 680%, when tested in accordance with American Society of Testing Materials procedure, these same mechanical shocks will not crack the insulation, but will flex it slightly. The butyl absorbs the energy of the shock and then returns to its original shape unharmed. The ability of the first butyl-molded transformer to withstand momentary overloads of 180 times full-load current without mechanical damage stems from the excellent physical properties of the butyl insulation.

Although butyl is generally considered to be susceptible to cold flow, the resistance to cold flow of this compound was found to be excellent and better than that of the asphalt-paper combination. It is also known that butyl burns; however, the rate of combustion is quite slow and is less than that of the old asphalt-paper wrapping.

Chemical Properties—An ideal insulation compound must operate satisfactorily under the adverse atmospheric conditions occasionally found in places where current transformers are located. The remarkably stable chemical properties of the new butyl compound make it ideal for almost all conceivable conditions. Also, its resistance to water absorption was found to be satisfactory for the application.

Although the first butyl-molded transformer is designed specifically for indoor use, it is anticipated that future designs may well be suitable for both outdoor and indoor applications. Evaluation of the material for such application is proceeding. Tests made in a weatherometer, which subjects the sample to alternate water spray and ultraviolet light, indicated no deterioration after 1,000 hr. of test. Thirty months' exposure to high humidity also showed no visible signs of degradation of the material tested.

The resistance of butyl to alkalis and acids is very good; thus, atmospheres that contain acids or alkali in suspension will not affect transformers insulated with this material. In common with most other insulating materials, however, butyl is affected to some degree by organic solvents.

Electrical Properties—In the selection of an insulating material, electrical properties are of primary importance. Extensive tests for dielectric strength, power factor, resistance to flashover, and other electric properties indicated that butyl compares very favorably with older-type insulating materials.

The dielectric strength of butyl under 60-cycle insulation-breakdown tests averaged approximately 400 v. per 0.001 in. for samples ⅛ in. in thickness. This is almost double the comparable value for asphalt-impregnated paper. In contrast to that of other materials, moreover, this dielectric strength remained high even when the temperature of the insulation was raised to a level far above the normal operating range. Asphalt-impregnated paper, for example, suffers a 40% reduction in insulation-breakdown strength when the temperature is raised from 77 to 212 F, which is within the operating range. Less than half this reduction is experienced with butyl, even when the temperature is raised from 77 to 266 F, which is far above the operating range. This means that with butyl the safety factor, represented by the amount the insulation voltage exceeds the operating voltage, remains at a high value despite considerable rise in temperature.

Another significant factor in determining the suitability of an insulating material is its power factor. If the power factor is too high, leakage losses through the insulation will cause internal heat to be generated, which will shorten the life of the insulation. In the case of butyl, the power factor of less than 1.0% falls well below that of most other solid dielectrics.

The ability of butyl to withstand repeated flashovers without formation of a low-resistance surface path is excellent. Arc-tracking tests, made in accordance with American Society of Testing Materials procedure, showed that butyl will withstand 130 sec. of repeated arcing, compared with 7 sec. for ordinary phenolic materials, 90 sec. for polyethylene, and 130 sec. for asphalt-impregnated paper.

Life Tests—In addition to having such excellent performance properties, however, a material is suitable for use as transformer insulation only if its life equals or exceeds the 30-to-40 years' operation span normally expected with instrument transformers. Therefore, accelerated life tests were made on butyl transformers under extremely adverse conditions, and results indicated a life expectancy well over these requirements.

Inasmuch as high temperature will in general deteriorate organic insulation very rapidly, several butyl-insulated transformers were operated at temperatures far in excess of normal to determine within a relatively short time the life expectancy of the new design. American Standard Assn. standards for service conditions require instrument transformers to operate in ambient temperatures up to 104 F with an average temperature over a 24-hr. period not to exceed 86 F. The upper limit can be extended by modified loading to 131 F.

The accelerated life tests made on butyl-insulated transformers were run at the substantially higher ambient temperatures of 250 and 302 F, and with 15% above rated voltage applied continuously. For purposes of control, several transformers insulated with asphalt-impregnated paper were included in the 250 F test, but because the higher temperature would have melted the asphalt-type insulation, only butyl transformers were subjected to the 302 F run. During the tests the transformers carried full-load current for 12 hr. out of every 24 which, under the test conditions, resulted in an 86 F temperature rise in the windings. Thus, for half of the test period, the transformer windings operated at 356 F for the 302 F test, and 304 F for the 250 F test.

Mechanical-shock tests, as well as high-potential and other electrical tests, were made on the transformers at intervals during the life-test period. Under these adverse conditions of application, the four transformers in the 302 F test have operated for 1,500 hr. without incident, and 2,200 hr. have been recorded for transformers on the 250 F test. Although the asphalt control samples on this latter test have survived electrically, serious mechanical defects have been noted, characterized by cracks and charring of the insulation and by melting of the asphalt. The mechanical condition of the butyl transformers showed little change during the test.

These test results cannot be interpreted directly in terms of operating life under normal conditions because the development of butyl insulation has been too recent to permit a direct correlation between accelerated tests and actual life. However, the results of the tests indicate that butyl-insulated transformers should have a longer service life than superseded types that are insulated with impregnated-fibrous material.

The effect of repeated change in temperature and humidity conditions was checked by cycling a group of four transformers between -40 and 167 F, and 90% relative humidity. The transformers were left, without voltage or current, in each condition for 24 hr., and were moved directly from one condition to the next. Eleven hundred hours of test have been recorded without incident. Here again, asphalt-paper-insulated transformers were included in the tests with butyl, and although electrical failure did not occur in either type, there were marked indications of surface cracking on the asphalt-paper transformers. Tests at intervals showed no change in the transformer properties.

Silicon Steel Core

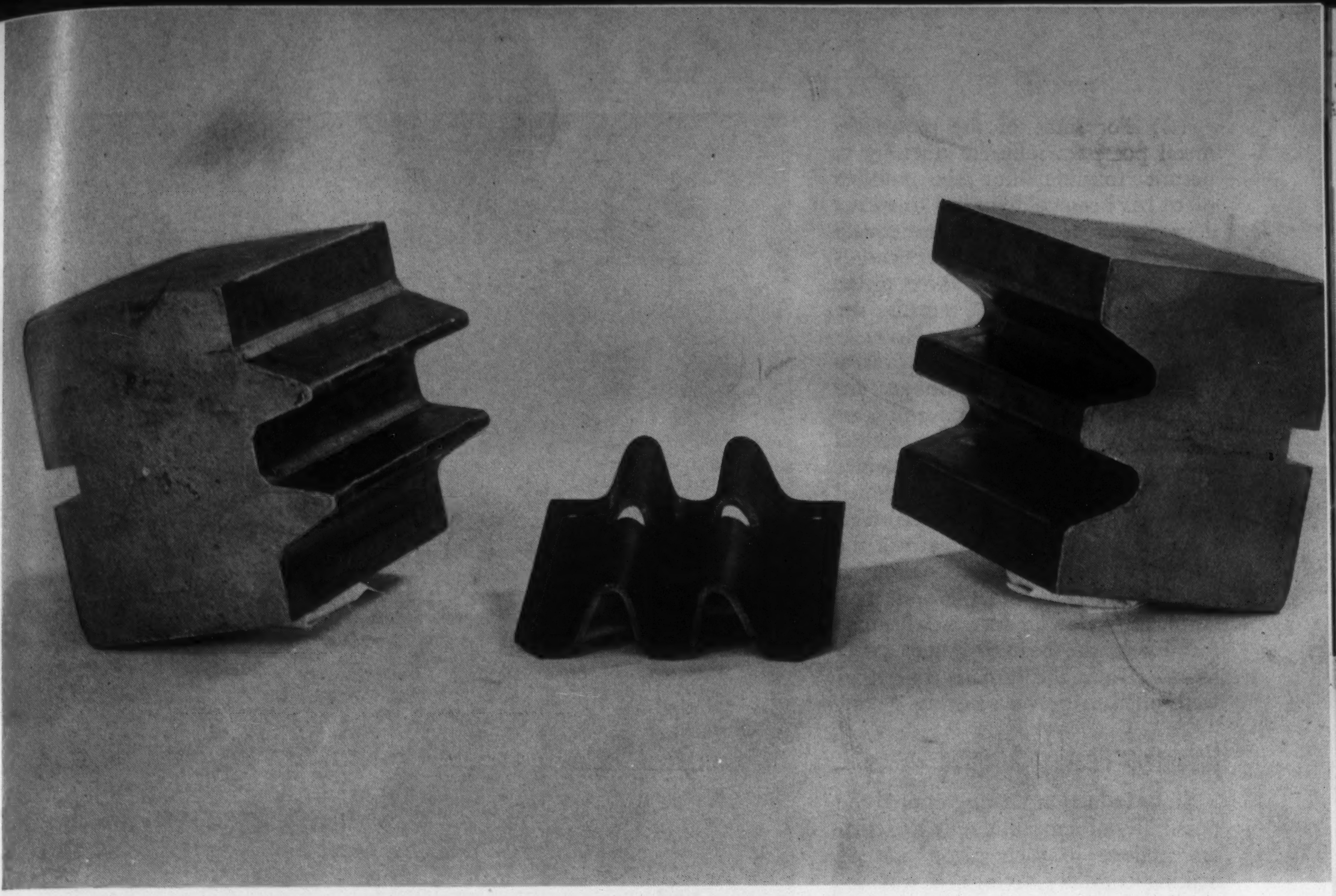
A revolutionary method of insulation, however, is not the only factor in the superior performance characteristics of the new transformer. The core is made of a silicon steel strip that is characterized by having high permeability and low losses in the direction of rolling, but poorer qualities when the flux is made to flow across the grain. Full advantage has been taken of these directional properties by designing the core so that the flux always flows along the length of the strip.

Of course, the best possible properties would be obtained if the core were wound from a continuous strip without joints. Inasmuch as this is impractical from the standpoint of assembling the windings onto the core, the best compromise is attained with the interleaved joints. This type of joint provides the maximum stability of accuracy, since there is no possibility that a shift in core position will change the reluctance of the joint.

In conclusion, it should be said that in addition to the immediate advantages cited in this article, the development of butyl-molded insulation also has many broader implications. The process is, for one thing, more adaptable to mass-production methods than older techniques. Then, too, the possibility of using this insulation eventually for outdoor transformers—transformers that might well be as light and convenient to use as present indoor designs—is of great significance. In fact, this new butyl-molded transformer represents the first step in an entirely new approach to instrument-transformer design.

Properties of Butyl Insulating Compound

Property	Butyl	Asphalt-Paper
Tensile Strength (ASTM-D-412-41)	750 psi.	—
Elongation at Breakage Point (ASTM-D-412-41)	680%	—
Thermal Conductivity in Calories/Sec./Cm^2/°C/Cm	6×10^{-4}	5×10^{-4}
Modulus of Elasticity	275#/sq. in. @ 300% elongation	—
Resistance to Water Absorption	Satisfactory for application	Satisfactory for application
Flame Resistance (Butyl will burn, but at a slow rate of combustion)	Fair	Poor
Resistance to Abrasion	Fair	Poor
Insulation Power Factor	0.5%	1-3%
Dielectric Constant	2.5	4
Resistance to Cold Flow	Excellent	Good



Stampings having sharp bends similar to this roof bow clamp bracket could be locally annealed to facilitate forming. (Courtesy White Motor Co.)

Induction Annealing of Light Steel Stampings Increases Production, Cuts Costs

Selective annealing in critical areas of small automotive stampings before or after forming prevents cracking and restores ductility.

by H. R. CLAUSER, Associate Editor, Materials & Methods

• THE ADVANTAGES OF induction heating have long been recognized in the hardening of steel. It makes possible rapid heating, sharply localized to the work area, with a minimum of distortion and with oxidation of the work surface limited to slight discoloration only. These same advantages are also gained when this heating method is applied to heating of steel for other purposes, such as forging and annealing. A recent application at the plant of the A. O. Smith Co. makes use of the high production features of induction heating to anneal light steel stampings, and to anneal the blanks before forming in the presses. Substantial savings have been made over the annealing methods previously used.

Manufacture of automobile underframes for several of the largest companies in the automobile field is an important part of the production of the A. O. Smith Co. The steel used is a deep drawing grade of SAE 1110 composition. Main members of the underframes are formed in special presses in the frame plant, but the smaller pieces, such as straps, brackets and cross ties, are pressed to shape in high production presses in other departments. As many of these smaller pieces are severely cold-worked in the forming operations, there is danger of serious weakening of the pieces. Difficulties with the stampings are of two kinds:

(1) Formed pieces requiring severe cold-working tend to develop hairline cracks at areas of maximum bending. To eliminate this, the pieces whose form indicates danger of such cracking, or which have shown a tendency to crack during production tests, are given a preforming anneal. Annealing of the blanks sends the steel to the presses in sufficiently ductile condition to permit the forming operations without tearing of the metal.

(2) For some of the pieces the metal possesses sufficient ductility to permit forming, but the finished piece has been cold-worked to such a degree that it possesses inadequate ductility for satisfactory service. A postforming anneal for these pieces restores ductility and returns the workpiece to serviceable condition.

It had been the practice to process the pieces through a continuous annealing furnace for the preforming or postforming anneals, and this method produced satisfactory work. But since the areas on the blanks or the formed pieces could not be given local treatment, it was necessary to anneal the entire workpiece. The steel was given an acid pickle before the anneal to eliminate scale and increase the uniformity of the heat treatment; after removal from the furnace the pieces were oiled to prevent rusting.

Induction Heating Adopted

Since induction heating offered the possibility of annealing only the critical sections in each piece, and of making corollary savings, it was decided to adopt this method. The first step was the design of a suitable induction heating unit, and of heating coils of a type suitable for the irregular blanks or formed pieces. Heating units operating at 450 kc. were produced. The heating elements were made from ⅜-in. copper tubing, water-cooled, and bent so as to make the best possible coupling with the workpiece while permitting manipulation of the steel. Most of the heating elements are in the form of tube bent to present a straight length to the area of the steel to be heated. Because of the shape of the pieces to be annealed, close coupling cannot be obtained in all cases. The coils give about ⅜-in. coupling in most cases.

The elements can be mounted with a hinge or pivot connection to the machine, spring actuated, so that the elements can be forced out of position to admit the work. As the steel may warp slightly at the bright red heat reached during the anneal, and the hot metal may come into contact with the coil, the coil is, in most cases, protected by a spade of asbestos-base building board. The spade also protects the coil against burning if careless handling permits the hot workpiece to touch the coil as it is being withdrawn after annealing.

With induction heating, production has been increased by annealing blanks for some of the pieces several at a time. This is possible because of the limited areas to be heat treated.

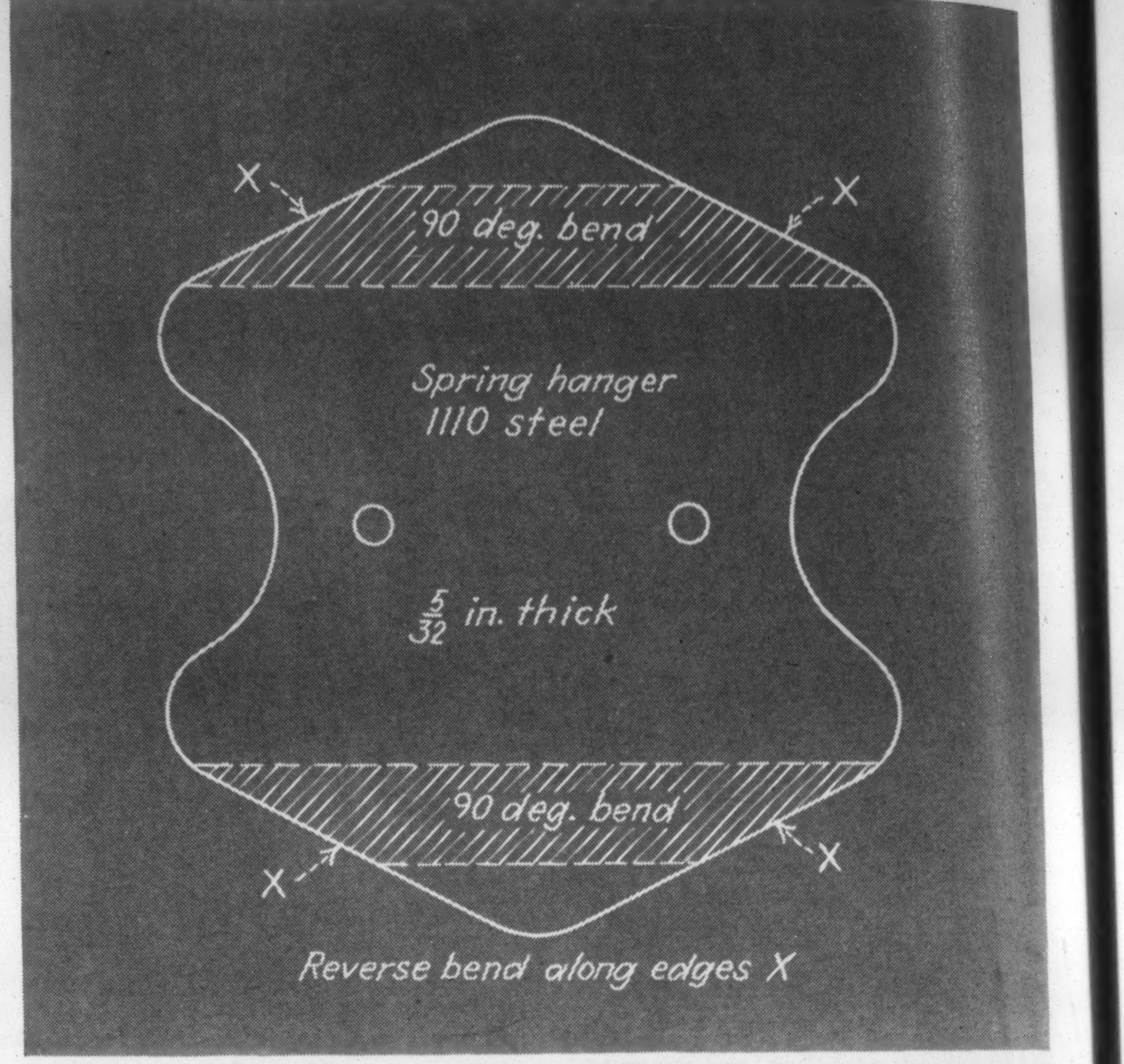
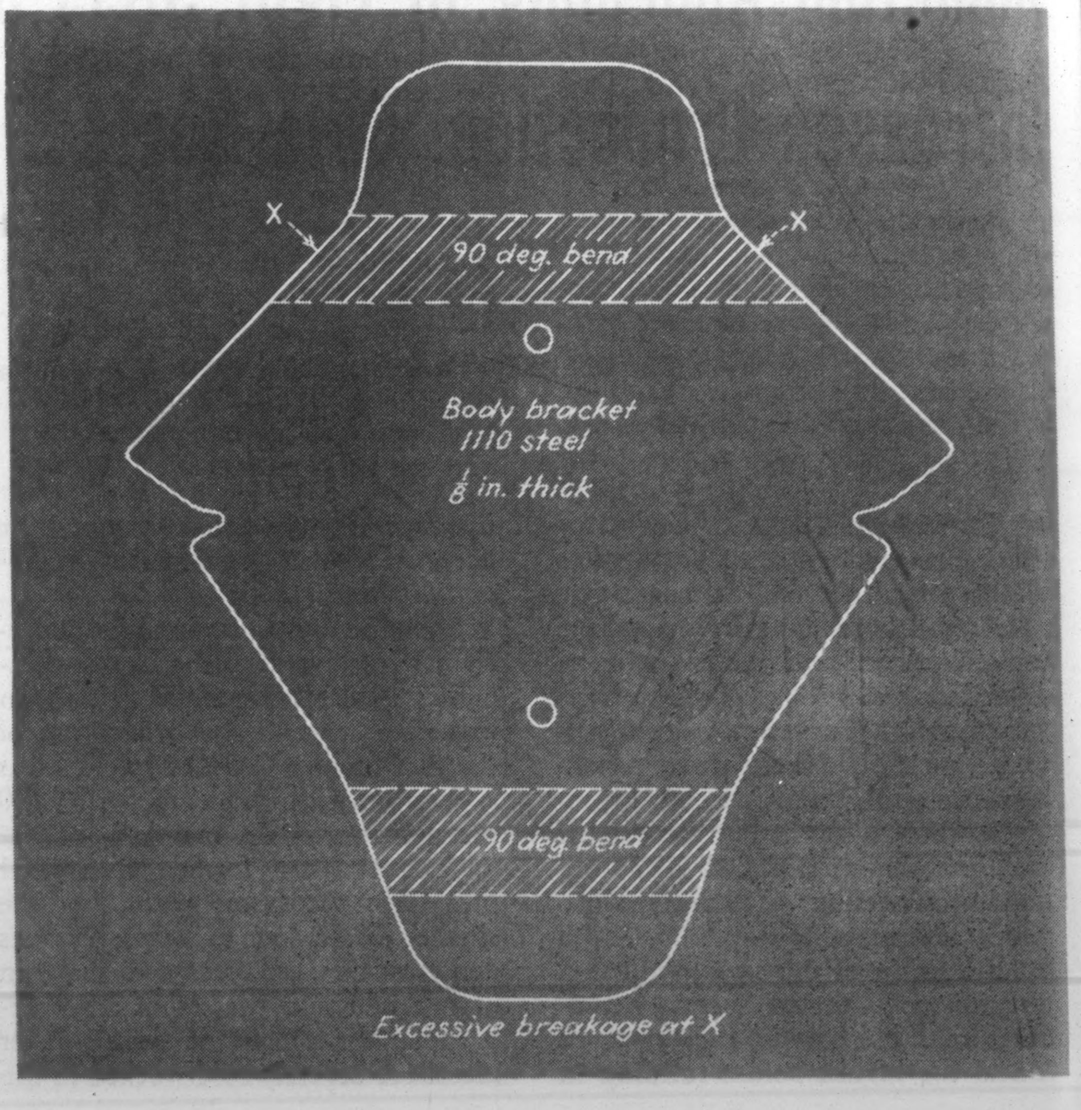


Fig. 1—Sketch of spring hanger blank. Cross-hatch regions are induction annealed before bending.

Fig. 2—Sketch of body bracket blank. The cross-hatch areas were annealed before being given a sharp 90-deg. bend.



In Fig. 1 is shown a spring hanger blank. This piece is given a 90-deg. bend along the regions marked at top and bottom, and a reverse bend along each side. The steel is 5/32 in. thick. So severe was the working of the metal at the point of reversal that the metal in a large percentage of the pieces was torn at the point indicated. Present practice is to anneal the blank at both of the zones marked. The time required for annealing is 18 sec., but the pieces are placed in the induction heating unit two at a time, so that a good production rate is obtained. Breakage has practically disappeared.

A body bracket gave considerable trouble before annealing of the blank was tried. Breakage during cold forming was nearly 100% when the ⅛-in. steel was given a sharp 90-deg. bend at the zones indicated. With induction annealing the blanks are heated at the section where the actual forming takes place. In order to increase production, the blanks are placed under the coils two at a time, one on top of the other. The actual thickness of metal being heated is therefore ¼ in. Annealing requires 9 sec., with a 2.5-kw. energy input to the machine. Breakage has been reduced to practically zero.

A difficult piece was another type of body bracket, formed of 9/64-in. steel. Here the piece was formed without breakage of the metal, but the steel was work-hardened at the zones of maximum deformation to such an extent that the finished piece was dangerously sensitive to shock. The difficulty was eliminated when a method for annealing the embrittled portions of the stamping was worked out. A good rate of production was obtained by heat treating the stampings four at a time in the machine.

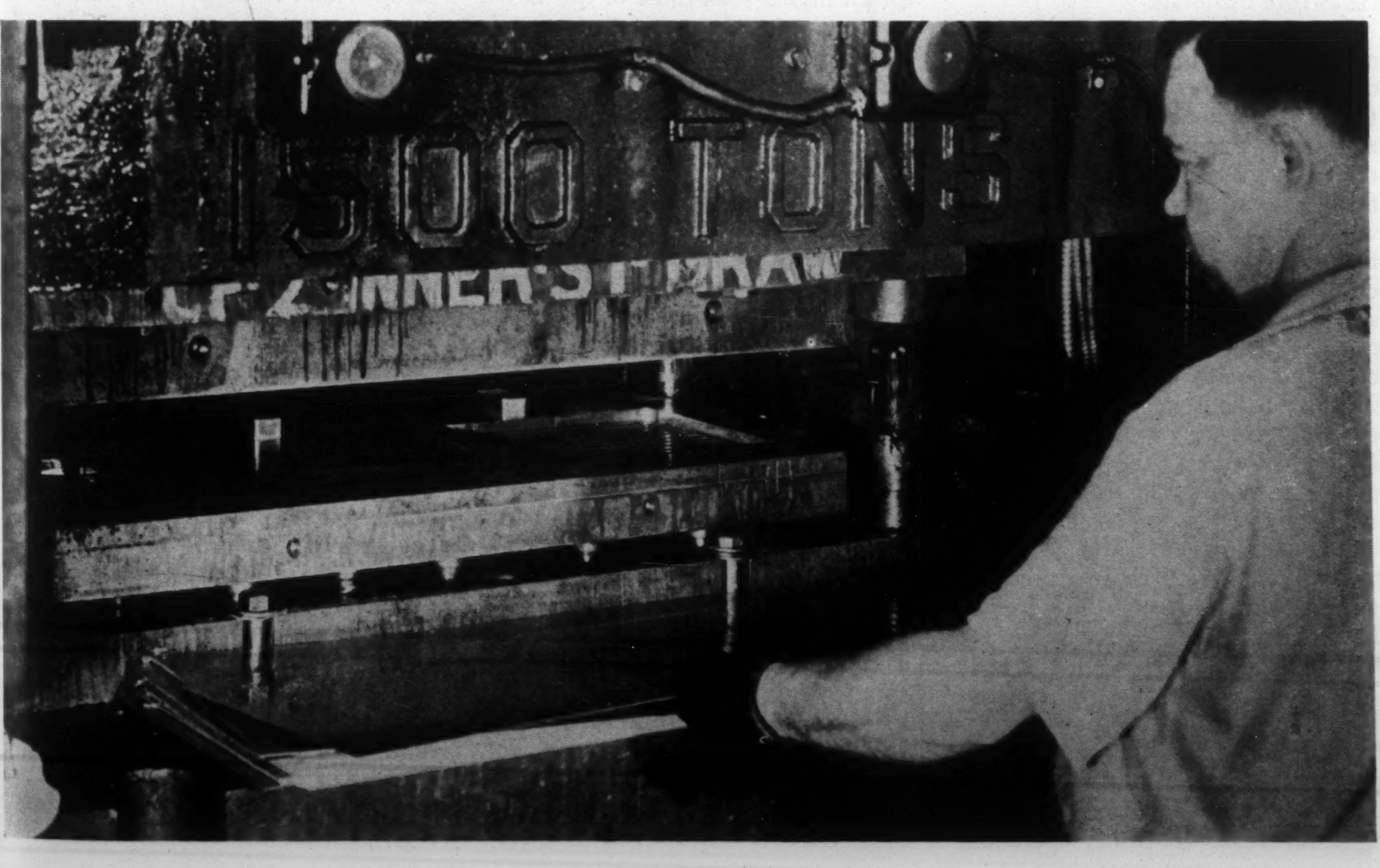
A control arm bracket was a problem piece also until induction heating for localized annealing was adopted. For this piece a steel blank 5/32 in. thick was formed in the presses so that surfaces at practically right angles were produced. It was found that corners of the finished piece along the line of deformation tended to tear rather easily, so that the bracket would be unsatisfactory in service. The localized anneal restored the ductility of the metal and obviated the danger of failure in service.

A kick-up reinforcement piece, 3/32 in. thick, was required to undergo severe deformation at two areas, and a hole was to be extruded at a third point. A preforming anneal at the three locations made possible the working of the steel without breakage.

A severe cold-working was required in the formation of a front crossbar for automobile frame from a steel blank. The blank was of 3/16-in. steel, and was of larger area than most of the other pieces. Forming the crossbar required that the blank be twisted, lengthened, and then bent to shape. Here it was found that an induction anneal before forming provided the extra ductility required to keep the metal from tearing.

In the annealing of another crossbar it was found that the workpiece distorted sufficiently when heated to annealing temperature to permit the hot steel to touch the coil. Protecting the heating element with a spade of asbestos board, using the standard building composition offered under the trade name Transite, protected the coil; however, it was quite difficult to get close coupling with the set-up and still to provide sufficient clearance to permit placing and withdrawing the workpiece. In this case a flexible mounting was provided for the coil, and the device was given a ¾-in. spacing to admit the work. The flexibly mounted heating element was held in place by a coil spring. When the crossbar was inserted the heating element was forced upward until the spacing in the machine became about 1½ in., with the spade resting against the crossbar. When the crossbar is withdrawn the spring returns the coil to the ¾-in. spacing.

Where severe cold-working is involved, light stampings tend to develop hairline cracks at areas of maximum bending. (Courtesy E. W. Bliss Co.)



Nonmetallic Materials Developed with Improved Magnetic Properties

—A NEW MATERIALS PREVIEW

A number of ferrites with a unique combination of magnetic and electrical properties have been developed and show great promise as core materials.

● MANY PIECES OF alternating current equipment are built around a magnetic core, and it is usually desirable that this core be constructed of a "soft" ferromagnetic substance. Until recently all technically important soft ferromagnetic core materials were metals, chiefly iron and alloys of iron. However, it has been known for a long time that certain nonmetals also exhibit magnetic properties, and now a series of ferrites has been developed that show great promise as core materials.

The term "soft" as applied to magnetic materials means that they retain little magnetism when removed from a magnetic field. When an alternating magnetic field is imposed on a magnetic core, currents will flow in this core just as the current will flow in the secondary of a transformer connected to a load. These currents are called "eddy currents" and are undesirable because they cause a dissipation of energy in the core; this energy is wasted as heat.

Two methods are commonly used to minimize this waste of energy. First, the core can be laminated or otherwise made up in cross section of numerous smaller parts; and secondly, the magnetic material can be chosen so that its electrical resistance is high and hence the eddy currents are small. Eddy current losses increase as the square of the frequency. This fact and the fact that even at 60 cycles it is necessary to laminate power transformer cores makes it clearly evident that the eddy current effect is a serious problem in the design of equipment for higher frequency operation.

Background of Development

Lamination has been carried to its practical limits, and cores are made of powders of the magnetic metals. The expedient of increasing the resistivity of the alloys to reduce eddy current losses is of small help since the resistivities of metals cannot be changed by large factors. Therefore, it is natural that magnetic materials that are nonmetals should be sought, for the resistivities ought to be very much higher than those of the alloys.

One such substance, magnetite, is perhaps the earliest known magnetic substance. It is not surprising to find that early in the present century a series of related chemical compounds were known to have magnetic properties. These compounds are the ferrites, compounds in which the amphoteric nature of iron brings it into the negative radical. The formula of magnetite is usually written Fe_3O_4 but the same formula can be written $Fe(Fe_2O_4)$, illustrating the fact that this substance is ferrous ferrite. A whole series of these ferrites is known, and of this series the ferrites of cupric copper, magnesium, manganese in the divalent state, nickel, ferrous iron and zinc are especially important.

Most of this listed group of ferrites exhibit ferromagnetism. They all have a crystal structure like the mineral spinel, $Mg\ (Al_2O_4)$. Any substance which crystallizes as this mineral does is said to have a spinel structure. For the various substances crystallizing in this manner, it has been found that there are two variations in the structure which have been called "normal spinel" and "inverse spinel" lattices. There are normal and inverse ferrites. This is important because it develops that the ferrites crystallizing in the inverse form are ferromagnetic while those taking the normal form are not. Of the list of ferrites given, all take the inverse crystal form except the zinc compound.

An additional discovery makes the zinc ferrite magnetically important also. As all of these ferrites are of the same crystal structure, they can form homogeneous mixed crystals in all proportions as solid solutions. Introducing the nonmagnetic ferrite into the magnetic compositions in homogeneous mixed crystals lowers the Curie temperature. Another fact that has been established is that all of the ferromagnetic ferrites have negative magnetostriction except the ferrous ferrite, for which the magnetostriction is positive. Magnetostriction can be minimized by mixing positive and negative magnetostrictive ferrites.

The practical value of these discoveries lies in the possibility they open for the development of high permeability ferrites. High magnetic permeability is obtained by minimizing crystal anisotropy and magnetostriction. At the Curie temperature magnetic anisotropy disappears, and somewhat below it, but near it, anisotropy is reduced. Therefore, introduction of zinc ferrite into the crystal composition in proper amounts minimizes anisotropy and the introduction of ferrous ferrite minimizes magnetostriction, making possible the high permeability compositions. The developments outlined above were the outcome of research conducted in the research laboratories of the Philips Company, Eindhoven, Holland.

Properties of the Ferrites

One of the most important features of the nonmetallic magnetic materials is the fact that they are very poor electrical conductors, and, therefore, eddy current losses are held to a low figure. This becomes highly advantageous at the higher frequencies, and it is in this field that these materials find their greatest practical applications. Electrical resistivity of the ferrite compositions may be 10,000,000 to 100,000,000,000 times that of the iron used for core materials.

Ferrites have been made up in several formulations to give a range of properties. While these compositions, and the properties given for them, are experimental, Ferroxcube III is now being manufactured as a standard article by the North American Philips Co. Some of the experimental properties of the ferrites are given in the accompanying table, along with those of several standard materials for dust cores.

Properties of Magnetic Ferrites and Standard Dust Cores

Dust Cores	Permeability	Hysteresis Coefficient ($\times 10^{-6}$)	Residual Coeff. ($\times 10^{-6}$)	Eddy Current Coeff. ($\times 10^{-9}$)
Grade B Iron	35	49	109	88
Grade C Iron	26	81	139	31
81 Permalloy	75	5.5	37	51
2-81 Mo-Permalloy	125	1.6	30	19
Ferrite Cores				
Ferroxcube 1a	1500	15	—	—
Ferroxcube 1b	600	10	—	—
Ferroxcube 2	400	10	—	—
Ferroxcube 3	2000	1	—	—
Ferroxcube 4	80	—	—	—

Nominal properties for the commercial Ferroxcube III are:

Initial permeability	600
Maximum permeability	1000
Resistivity, ohm-cm.	100
Saturation induction, gauss	3000
Specific gravity	4.8
Losses at frequencies to 100 kc.	
Hysteresis coefficient	2×10^{-6}
Residual coefficient	33×10^{-6}
Eddy current coefficient	0.5×10^{-9}

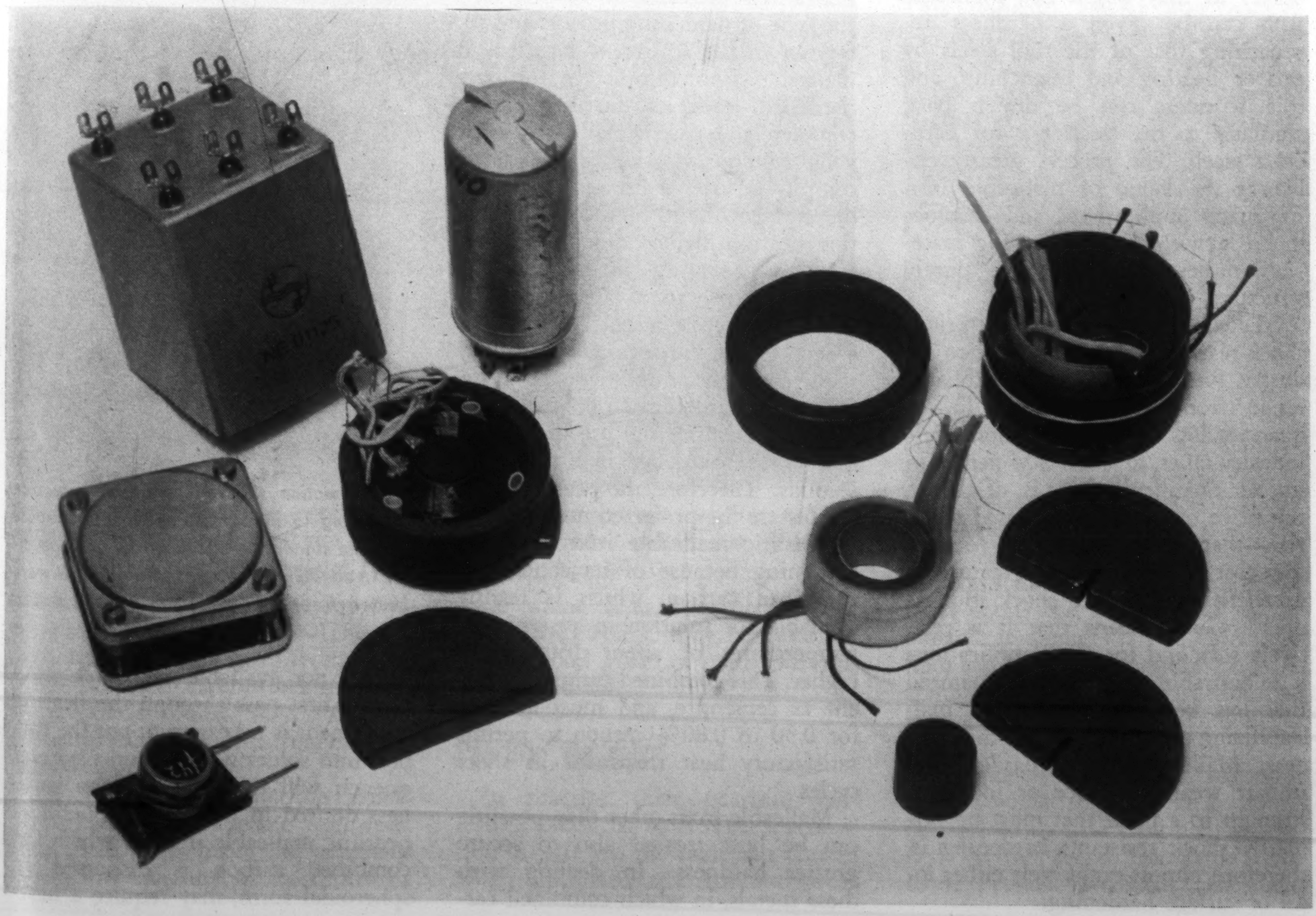
These figures are conservative, and it is possible to prepare a commercial article that will have an initial permeability of 1000 to 1500 and an hysteresis coefficient at 2 kc. of 1 to 4×10^{-6}.

Some idea of the effect of frequency upon the loss factor for Ferroxcube III can be gained from the following experimental data:

Loss factor,	*10 kc.*	*100 kc.*	*1 mc.*
tan delta/mu	8×10^{-6}	20×10^{-6}	170×10^{-6}

Ferrite magnetic materials are not in general satisfactory substitutes for iron at commercial power frequencies, as the saturation magnetization is lower than that for iron by about seven times. At the higher frequencies, such as are used in the communications field, advantages in performance and space saving are to be had in inductors, transformers, etc.

Circuit components using cores of the new ferrite materials. (Courtesy Philips Laboratories, Inc.)



Hardening Enhances Properties of Malleable Iron

Malleable irons — particularly the pearlitic types—can be surface and locally hardened to improve wear resistance or increase strength.

by KENNETH ROSE, Western Editor, Materials & Methods

● MALLEABLE IRON responds well to heat treatment, though the advantages to be obtained by heat treatment are not as widely used by industry as they might be. Malleable iron can be given a hardness approaching that of the tool steels by proper heating and quenching, and this hardness can be drawn back similarly to the treatment for hardened steel. The process greatly enhances the value of malleable iron for many applications, and classifies the iron with the engineering materials rather than with the purely structural materials.

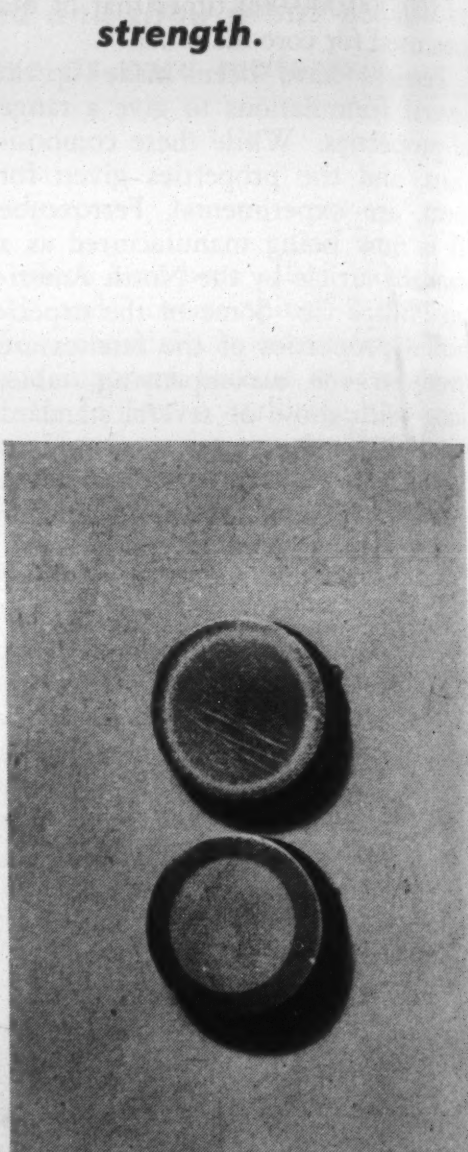
Malleable iron is the lowest-priced shock-resistant metal available to industry. Present prices would probably range from about 8¢ per lb. in quantity lots, such as the automobile industry takes, to about 20¢ per lb. in smaller quantities. This is, of course, the price of the rough formed material—that is, as cast. Along with its low cost is this important feature of excellent resistance to shock. But its ductility also means that it is relatively soft, and for some applications it is desirable to harden the material that has been put through a malleabilizing process to achieve this softness. Malleable iron is hardened to impart wear resistance or increased strength to a piece that must be primarily shock resistant; hardening is, therefore, almost exclusively either local or surface hardening.

All Types Hardenable

All malleable irons can be hardened, but hardening brings certain limitations that tend to restrict both the type of hardening process and the type of malleable iron to be used. A malleable iron completely through-hardened loses its ductility almost completely, and so would be of little value to industry. As hardening is accomplished over a limited area or at the surface of the piece only, induction heating, flame hardening, or radiant gas heating involving short cycles is usually used. With induction heating the cycle might be only 1 to 4 sec. Flame hardening will usually require a substantially longer cycle. Selective hardening of malleables therefore requires the use of a metal that can be hardened in a matter of seconds. Therefore, the pearlitic malleables are the preferred materials.

Pearlitic malleable iron is quick-hardening because of its content of combined carbon, which is readily available for solution in austenite at temperatures of about 1600 F or higher. This combined carbon is present as cementite, and must account for 0.30 to 0.80% carbon to permit satisfactory heat treatment in short cycles.

Malleable irons other than pearlitic can be heat treated also to secure greater hardness. In dealing with these metals, in which combined carbon is not available for quick solution, a first pass through the heating equipment is necessary to put the carbon into solution. A second pass and quench will then develop the hardness desired in the work. Spheroidal pearlitic malleable iron, in which the combined carbon is dispersed in spheroidal form, may require a heat-



A cut section showing result of induction hardening ½-in. bars of pearlitic malleable iron and standard malleable iron. The pearlitic malleable is at the bottom. Both were heated for 4 sec. and quenched in water. (Courtesy Chain Belt Co.)

ing pass preceding the hardening pass also, as the combined carbon dissolves more slowly in austenite from the spheroidal form.

The hardening cycle for these nonpearlitic malleables might be as follows:

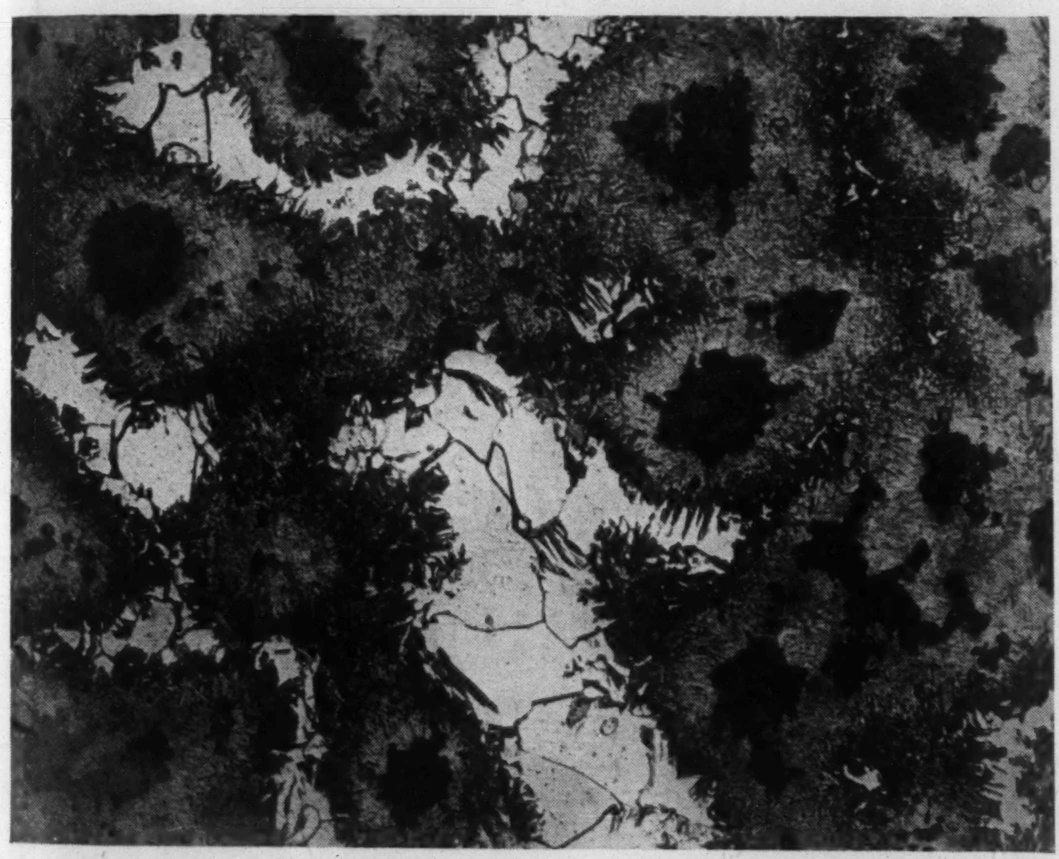
First Pass—heat to 1700 F or slightly higher, to dissolve graphitic carbon.

Second Pass—heat to 1450 to 1550 F and quench in oil or water.

This treatment should give a hardness of about 50 or higher on the Rockwell C scale. Nonpearlitic malleables are usually quenched in water.

Pearlitic malleables for hardening have been the subject of special study by a group in the Iron and Steel Technical Committee of the Society of Automotive Engineers, jointly with an A.S.T.M. committee, and their conclusions which follow will be helpful to all users of malleable iron in hardening applications.

(1) Specification by combined carbon content is not always completely satisfactory. Studies of combined carbon determinations as made in routine analyses showed that these results are not consistently accurate. The determination is made by difference between the total carbon and the graphitic carbon content of the sample, and so is subject to the errors of both determinations.



A photomicrograph transition zone between hardened surface and soft core in a standard malleable. A martensitic structure is seen around each carbon nodule, with unaffected ferrite. Picral etch (300X). (Courtesy Chain Belt Co.)

(2) It was decided that the Brinell hardness of the malleable iron constituted an easily made and generally satisfactory measure of its ability to develop local hardening by such short time treatments as induction heating or flame hardening. After much experimental work the recommended value fixed upon as the minimum Brinell reading for such hardening was 197. This corresponds to a combined carbon content of about 0.40%.

(3) While different malleables show different responses to heat treatment for hardening, the difference between all the pearlitic malleables and the other malleables was so much greater than the differences among the pearlitic types that the pearlitics generally were agreed upon as the type for local hardening.

Malleabilizing may produce a decarburized surface, in which hardening would be erratic or incomplete. For this reason it is best practice to heat treat machined surfaces to develop high hardness. When the hardened surface must possess a degree of toughness, a tampering treatment on the hardened area will accomplish the desired result. A draw at about 600 F will greatly decrease brittleness without lowering the hardness to the same extent. A hardness of about 52 to 57 Rockwell C may be expected with a good grade of malleable iron after this draw.

Pearlitic Malleable

In practice, then, pearlitic malleables produced to ASTM Specification A-220 are the materials chosen when improved strength and wear resistance, and when local hardening is required, as against the standard malleable iron made to ASTM Specification A-47. The single pass through quick-heating equipment makes it possible to develop the required hardness with minimum risk of warpage or excessive oxidation in the piece.

The pearlitic malleable irons are obtained by several variations in the malleabilizing process that give incomplete graphitization, so that some of the carbon is retained in combined form, usually as pearlite. The process of graphitization can be interrupted, or retarded by an additive, or the completely graphitized metal can be reheated to effect partial resolution of the graphite content.

Graphitization can be interrupted by shortening the annealing cycle during malleabilizing. Whereas the malleabilizing of cupola malleable iron requires about six days, some of the newer cycles for malleabilizing require as little as 30 hr. Producing pearlitic malleable of a good quality by interrupting the graphitization at the proper point depends upon setting a furnace cycle to correspond to the composition of the metal being heat treated. Holding at a temperature above the critical for a period long enough to destroy all primary carbides is the first part of the heat treatment for malleabilizing iron. This standard anneal may require 2½ to 3 days, and converts the white iron casting to a material having a ferrite matrix in which are dispersed nodules of temper carbon. The holding temperature is about 1550 to 1600 F or higher. During the cooling the high silicon content retards the conversion of austenite to pearlite, and the graphitization can be speeded by increasing the amount of silicon, *i.e.*, increasing the retarding factor.

Typical of the pearlitic malleables produced by use of an additive is the material offered under the trade name of Z-metal. Manganese is used as the retarder, in amounts of 0.5 to 1.0% above the amount that would be used to produce a similar alloy in ordinary malleable iron. The manganese can be added to the iron in the ladle. In this case the metal is air quenched from above the critical, then spheroidized at about 1325 F. Molybdenum can be used as a retarder also, in amounts of 0.15 to 0.20%. Chromium is an energetic retarder in amounts of 0.1 to 0.3% or less.

Completely graphitized malleable iron in which some of the carbon is redissolved by heat treatment is typified by the metal using the trade name Promal. Here the heat treat-

Induction heating methods are frequently used for selective hardening malleable irons. (Courtesy Budd Wheel Co.)

ment that would correspond to the first pass in hardening malleable iron is performed as a part of the original production of the material. It can be produced in various grades, as the application may require.

In general, the pearlitic malleables have a higher average yield point and higher ultimate strength than ordinary malleables. Elongation is lower, and hardness is higher. While the pearlitic malleables can be machined somewhat more readily than drop forgings or steel bar stock of the same hardness, it is slightly more difficult to machine than the standard malleables.

Specifications for pearlitic malleable iron castings, including those suitable for localized hardening, have been developed in joint A.S.T.M. and S.A.E. committee work. A tentative specification, A.S.T.M. A220-44T, has been prepared by the American Society for Testing Materials to cover the malleables suitable for selective hardening. The standard of the Society of Automotive Engineers, substantially in agreement with the A.S.T.M. specification, lists four grades of pearlitic malleable iron, and sets up grade numbers in which the first three digits are the yield strength of the material in hundreds of pounds per square inch, and the last two are the elongation expressed as percent. The physical properties of the four grades are given in the accompanying table.

The specification recognizes that while higher tensile and yield strengths can be obtained for any of the grades shown by using a quench and temper treatment as part of the production process, a reduction in toughness and probably an increase in hardness would accompany the gain in strength.

When the castings are to be specified for selective hardening processes, the letter L is prefixed to the grade designation. The castings should then contain sufficient combined carbon to permit satisfactory localized hardening, and free ferrite should be as low as would be consistent with other properties. In the case of grade 43010, the minimum elongation requirement of 10% may be reduced in favor of greater hardenability of the material, permitting the content of combined carbon to be carried slightly higher.

	Grade 43010	**Grade 48005**	**Grade 60003**	**Grade 70002**
Tensile Strength, Psi.	60,000	70,000	80,000	90,000
Yield Strength, Psi.	43,000	48,000	60,000	70,000
Elongation in 2 In., Percent Min.	10	5	3	2
Typical Brinell Hardness Range	163-207	179-228	197-241	241-285

Nonslip Materials Find Wide Use in Industry

by **T. C. DU MOND**, Editor, Materials & Methods

Wherever safety underfoot must be provided, the engineer has a wide range of special low-friction materials, both metallic and nonmetallic, from which to choose.

A nonslip walkway is created on this diesel locomotive by a grit-surfaced fabric applied with a pressure-sensitive adhesive. (Courtesy Minnesota Mining & Manufacturing Co.)

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● IT IS TYPICAL of the diversity of properties required in materials that, while engineers devote much of their research to producing low-friction materials, another group of materials has high friction as its primary requirement. These are the nonslip materials used for floors, stairs, ramps, etc. in factories; for machinery and apparatus platforms; for special mats and tiles; for certain types of nonskid patches under movable equipment; and for locomotive steps and platforms, railway car steps and platforms, running boards and tailboards on trucks, etc.

Increasing consciousness of safety for employees and for the public has brought wider recognition of the value of nonslip materials also. Hotels, hospitals, office buildings and schools now regard nonslip materials as a necessary part of their construction. Suitable materials are available for the types of service to be encountered, and for indoor and outdoor use.

For industrial use, where the problem of oily walkways must sometimes be considered, and where attractive appearance is secondary to durability, there is a wider range of serviceable nonslip materials in use. Door and elevator sills, dockboards, floors and ramps must not only provide assurance against slipping but must frequently withstand the impact of wheels of heavily loaded skid trucks, contact with heavy metal pieces, and abrasion from metal chips. Corrosive chemicals are an additional problem in some fields.

The cement floor of this plant contains a gritty aggregate to provide nonslip qualities. (Courtesy Norton Co.)

Nonslip materials used in industry are of several general types.

Textured Metal—The nonslip feature may be obtained by (a) using expanded metal alone or embedded in concrete, or (b) knurled sheet or plate, in which slightly raised figures form a pattern over the surface of the material. Steel is used for this purpose, and in the case of the knurled stock the figure is rolled into the surface.

Abrasive-Impregnated Plate—This is one of the newest of the nonslip materials. Mild steel plate is given an abrasive surface by rolling the grit into it. The abrasive is Alundum, and the 16-grain-size is used.

Abrasive-Embedded Cast Metal—Cast iron, bronze, aluminum and nickel bronze are standard matrix metals, and abrasive grains cast into the metal project slightly above the surface to provide the antislip quality. This material has been standard for more than 30 years.

Abrasive-Embedded Plastics—Several types of plastics, especially a phenolic resin, are the base and bonding agent in tiles having abrasive grains embedded in the surface.

Abrasive Ceramic Tile—Here the abrasive is held in a vitreous or semivitreous matrix. Of the same general type is the use of strips of bonded abrasive at critical points, such as stair nosings.

Abrasive-Surfaced Woven or Felted Material—The abrasive grains are usually adhesive-bonded to the fabric, which may be asphalt-impregnated. The fabric may be adhesive-bonded to the floor or other base, or, in a new type, may be supplied as a tile with pressure-sensitive adhesive coating on the underside protected by a strippable muslin.

Trowelling Mixtures with Abrasive Constituent—These range from ordinary cement to which a solid grain abrasive is added by sprinkling on the freshly-laid surface to special trowelling compositions containing an angular-grain abrasive. The method gives a wide choice of texture, composition and form for the nonslip surface.

Antislip Paints—Special paints that contain an abrasive constituent are on the market. The nonslip quality is much more enduring in these products than in such substitutes as sand sprinkled over wet paint.

Metallic-Base Materials

Of the types of nonslip materials listed, the first three, with metallic base, can be used as structural materials. These metallics have good strength properties and can be designed as load-carrying members of the structure or product, rather than as specialty materials having only nonslip qualities. When built into a railway car as platform or steps, the metal forms the structure itself and provides antislip protection in addition. The metals have long life and can be expected to last as long as any other part of the structure if the amount of wear be taken into account.

In the rolled forms, wide range of sizes are available. Thickness can be substantially reduced over that for the cast metal when large-area plates are needed. In addition, several plates can be welded together to produce a structural unit that will possess the desired friction properties. In the case of the cast plates, size range is limited by the need for sufficient thickness to make the piece castable. This requires a minimum of 5/16 in. in cast iron slabs and shapes, or ¼ in. in the nonferrous metals. Thickness must increase as the length and width of the piece become larger.

The rolled forms can be readily welded into the structure. As the metallic material is mild steel, it welds easily to other steel structural parts. The plate can also be flame-cut to intricate plane forms, or bent, hot or cold, if necessary. They are thus more flexible in fabricating possibilities.

Cast forms are more easily produced in special cross-sections, or in unusual surface effects than are the rolled forms. Slabs and standard fittings are available in several metals to harmonize with various types of interiors, and in several surface patterns. Standard architectural forms, such as door saddles, trench covers, elevator door sills, and spiral stair treads, are cast in a variety of sizes.

With the textured metals the antislip surfacing is, of course, a part of the metal itself. The abrasive-surfaced metals have the nonmetallic grains evenly distributed and firmly and permanently held, with sufficient depth of abrasive to eliminate danger of wearing smooth. Even with the rolled-in grit, the particles penetrate to a depth of 1/16 in. or more. The abrasive types remain nonslipping under difficult conditions. Under wet,

Flight deck of the U.S.S. Midway is covered with a grit-faced fabric held with pressure-sensitive fabric. (Courtesy Minnesota Mining & Manufacturing Co.)

dry or oily conditions the abrasive surface resists any sliding.

Nonmetallic-Base Materials

Several of the nonmetallic-base antislip materials show some similarities, and can be grouped for comparison. Plastic tile, ceramic tile, and fabric or asphalt-base materials are all light in weight compared to the metallics; they are nonrusting, somewhat less durable, and are used as nonslip coverings for other floors or structures rather than as structural materials themselves. They are easily laid over existing floors in most cases. They are not intended for flooring where there is heavy trucking, or for like severe service. There is usually a choice of colors, wide in the case of the ceramic tile, limited to dark colors in the case of the plastic, asphalt or fabric coverings. Ceramic tile is about as durable as the metallics, except for resistance to severe local impact. It is the least flexible of this group in installation procedure.

Plastic tile is lighter than ceramic tile, easier to install than ceramic tile, but because it, too, is produced in pieces of fixed shape it is only slightly more flexible in adaptation. It has good resistance to moisture, good antislip qualities under adverse conditions, and has the advantage over some of the asphalt materials of being fire-retardant. It is installed by adhesive bonding, whereas the ceramic tile may be installed by adhesive bonding or by bedding in mortar.

The asphalt and the fabric-base types of material are the simplest to apply, the most flexible in adaptation, and one of the lowest in cost. They can be used as tiles, as sheet material, as narrow strips at critical spots, or as cleats along the walkway. Narrow strips make good nonslip stair nosings. They can be had in a range of dark colors.

Easy-installing fabric-base materials made with pressure-sensitive adhesive backing have been mentioned. These include both tile and roll forms. They make excellent materials for emergency installations, and are quite durable on the job also. Ease of application is their chief advantage over other materials in the same group. When applied with the proper adhesive, the fabric-base materials are not affected by oil or gasoline. The oil drilling and refining industry has, in fact, been one of the large users.

The trowelling compositions require a certain amount of skill in their application to obtain best results. Abrasive grains can be scattered over the surface of wet cement and "floated" in to produce an antislip surface that is cheaply made and entirely satisfactory for many purposes. The special compositions contain the abrasive in the mixture, and are applied as very thin layers, over wood, stone, steel, etc. One of this latter type has been used successfully to produce a nonskid surface on the tailboards of trucks.

Antislip paint is the most adaptable of the abrasive materials used for this purpose. It can be used in the same way as ordinary paint, but the abrasive contained in it imparts a degree of resistance to slipping. Cost is quite low, and it is easy to apply.

Uses of nonslip materials in industrial buildings and manufactured articles is broad, but the range of types of materials available is wide enough to meet it. Furthermore, the materials engineer has a choice of methods of application, of design factors, and of costs.

Acknowledgment

The following companies making nonslip materials have supplied information for this article:

The Carborundum Co., Niagara Falls, N. Y.—materials offered under the trade name Speedi-Tred, and also bonded silicon carbide stair tread strip, and abrasive grains and powders.

The Norton Co., Worcester, Mass.—materials offered under the trade name Norton, in abrasive stair and floor tile, mosaic tile, and grains and powders.

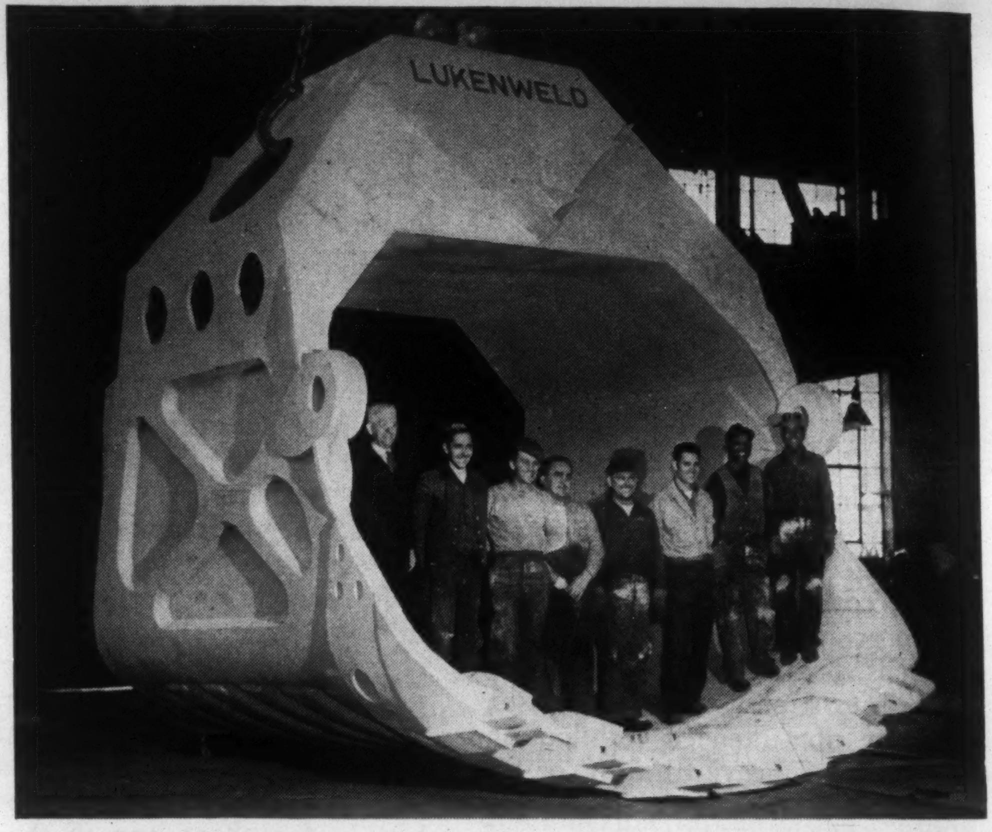
Minnesota Mining & Manufacturing Co., St. Paul, Minn.—bonded fiber-backed abrasive strip and tile, for adhesive bonding to subfloor, etc., sold under the trade name Safety-Walk.

American Abrasive Metals Co., Irvington, N. J.—case metal plates and shapes (Feralum, Bronzalun, Alumalun, Nicalun), Amcolun (plastic tiles), Martex (plastic nosings and strips), Ferrox (trowelling composition), Fera-Mat (fabric-backed floor covering), Fera-Flow (floor paint).

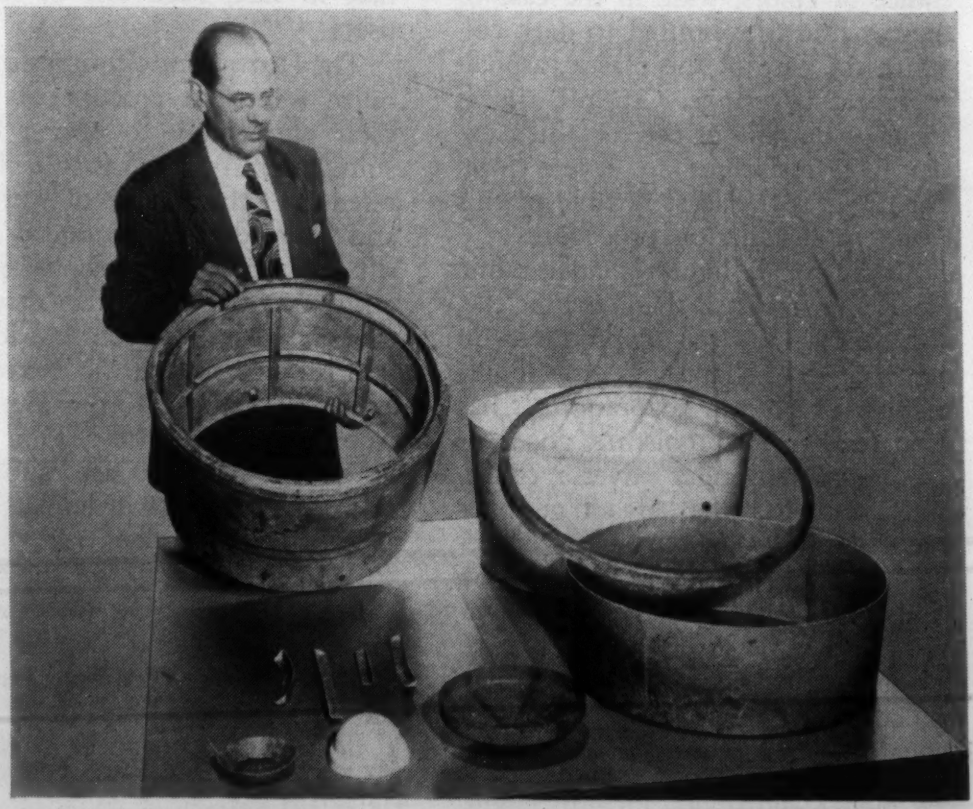
Alan Wood Steel Co., Conshohocken, Pa.—steel plate with rolled-in grit, under the trade name Super-Grip.

Materials at Work

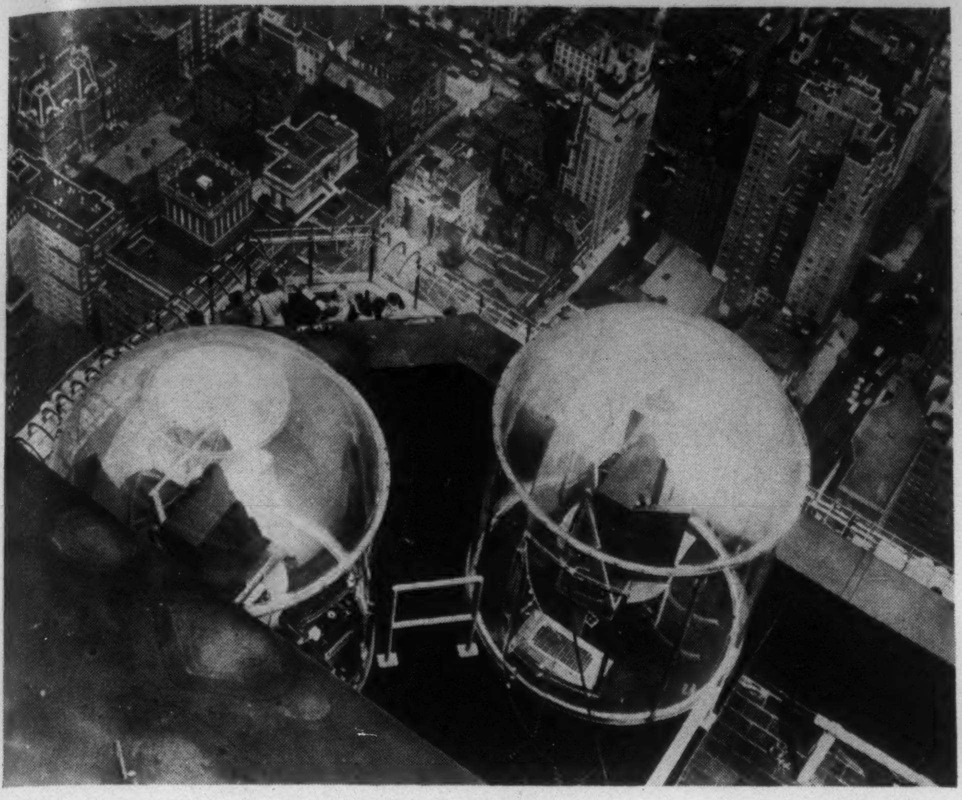
Here is materials engineering in action . . .
New materials in their intended uses . . .
Older, basic materials in new applications . . .



WELDED SHOVEL DIPPER *Reportedly the world's largest, this 55-cu.-yd. strip-mining bucket was fabricated of welded steel plate by the Lukenweld Div. of the Lukens Steel Co. The basic structure is made of manganese-molybdenum and austenitic steel plates, 1 to 3 in. thick. Over 90% of the plates that were sheared, shaped, assembled and welded for this unit have an ultimate tensile strength of 110,000 psi. The dipper measures 11 by 13 by 12 ft. and is mounted on a 54-ft. boom. The complete chassis, boom and shovel is electric-powered and can cut a path into the earth 80 ft. deep and 90 ft. wide without moving from position.*



MOLDED GLASS MACHINE PARTS *Four different parts for automatic washing machines are being molded of Fiberglas-reinforced laminates by the Apex Electrical Manufacturing Co. The parts comprise water balance rings, suds guards, clothes guards, and water deflectors. The water balance rings measure 22 in. in dia. and 12 in. deep, and consist of 41 separate parts. The Fiberglas material is supplied in strands containing 200 flexible filaments or fibers, each 0.003 in. in dia. and 2 in. long. These are mechanically separated, blown onto a "preform" screen, sprayed with liquid binder, and then baked at 300 F. After baking, the preform is placed in a heated steel mold and the thermosetting resin added. While in the mold, the form is subjected to 45-ton pressure. After removal from the mold, the form is ready for assembly.*



TRANSPARENT ACRYLIC ANTENNA DOMES *Designed to protect television antennas on the Empire State Building in New York City from damage caused by falling ice, high winds, etc., these Plexiglas domes readily permit the passage of microwaves without hindrance or distortion. The transparent housings, produced by Rohm & Haas, Inc., are 8 ft. high and have manholes in the tops to permit entrance for inspection and adjustment of the enclosed apparatus.*

ALLOY STEEL CYLINDERS *Made from special high tensile strength alloy steel to I.C.C. specifications by the Harrisburg Steel Corp., these 100-lb. capacity propane cylinders weigh only 72 lb. and are available with or without pressed steel caps. Advantages claimed for the lightweight bottles include increased corrosion resistance, uniform thickness throughout, easier handling due to smooth-side construction, and greater payloads.*

ETHYL CELLULOSE ROLLER PRINTER *Produced by the Hamilton Art Metal Corp. of Celcon, a product of the Celanese Corp. of America, this manually-operated roller printer is designed to stamp with one motion on any type of surface. The plastic housing reduces the over-all weight of the unit to only 8 oz. and prevents damage to fragile surfaces on which the printer is used. The shatter-proof qualities of the ethyl cellulose plastic effectively reduce the danger of jagged splinters, should accidental breakage occur.*

GLASS
HANDLE WITH CARE
GLASS
HANDLE WITH CARE
GLASS
HANDLE WITH CARE

ALUMINUM ALLOY HOIST *Weighing only 8½ lb. and fabricated from aluminum alloys by the Lincoln Precision Machining Co., this portable hoist is capable of lifting a 1½-ton load. To eliminate the kinking often encountered with standard chains, the Lug-All hoist utilizes a 133-strand aircraft cable, shielded to prevent backlash. As an extra safety precaution, the aluminum alloy handle is designed to bend before any part of the hoist approaches its rupture point.*

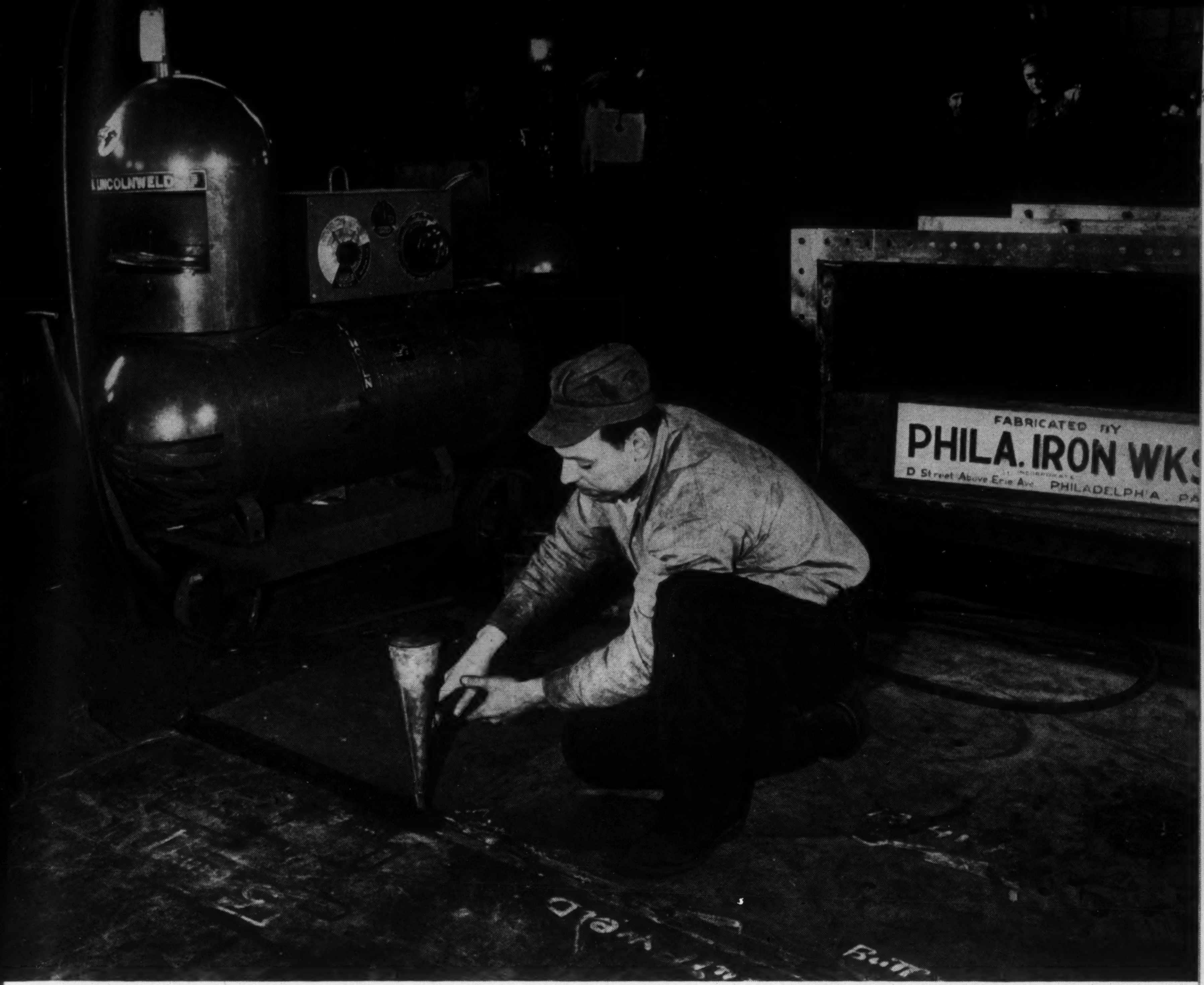
Welding inside a chemical reaction tank. The tank revolves to give the equivalent of automatic operation with the manual welder.

Manual Submerged Arc Process Simplifies Welding for Many Uses

Hand method of submerged arc welding offers a versatile means for welding in irregular and otherwise inaccessible locations.

by C. G. HERBRUCK, The Lincoln Electric Co.

• THE AUTOMATIC submerged arc process for welding, in which bare wire is used to provide weld metal and the molten metal is protected by a separately applied flux, is now a standard method for laying down heavy beads in few passes. It is also a standard process for welding material as thin as 20 gage. It was used extensively during the war in shipbuilding and other fields where heavy steel plate was welded. The process, however, requires a careful machine setup so that the welding head will either follow a path along the line of the weld or else the work will pass under the head. Feeding of the wire through the welding head is controlled by the voltage drop across the arc, so that as the wire tends to lag, increasing the voltage drop, the motors driving the feeding rolls are increased in speed. Because of the control required, an automatic setup can only be economically justified where



Welding ½-in. plates for 100% penetration without edge preparation. The welder here is used manually at a speed of 22 in. per min.

a large volume of uniformly shaped pieces is to be produced. In the Lincoln Electric Co.'s manual *Lincolnweld,* however, the equipment for submerged arc welding is simplified. The direction and speed of travel of the arc is controlled by the operator and moved by him in the same manner as a simple electrode holder.

Welding with the manual submerged arc process resembles manual shielded arc welding, except that the operator is not inconvenienced by the arc rays and the smoke from the electrode coating. It is simpler in that the length of the arc is automatically controlled by the mechanism feeding the weld wire instead of depending upon the skill and judgment of the welder. The granular flux, similar to that used in the mechanical submerged arc process, is fed onto the line of weld around the electrode and arc through a conical funnel, and without any mechanical devices. It trickles out of the lower end of the funnel by gravity at a rate dependent upon the size of the orifice in the funnel. The funnel is filled with granular flux from a bucket or other storage container, and is then ready for use.

The manual submerged arc welder is powered by an ordinary arc welding motor-generator, which makes the entire equipment easily portable. The wire used is 5/64 in. in dia., and at the high amperages used, usually 400 to 600 amp., weld metal is deposited rapidly. Speed of travel, even with plate up to 1-in. thick, is fast, and the weld groove can usually be filled in one pass. Current densities are said to be the highest ever used.

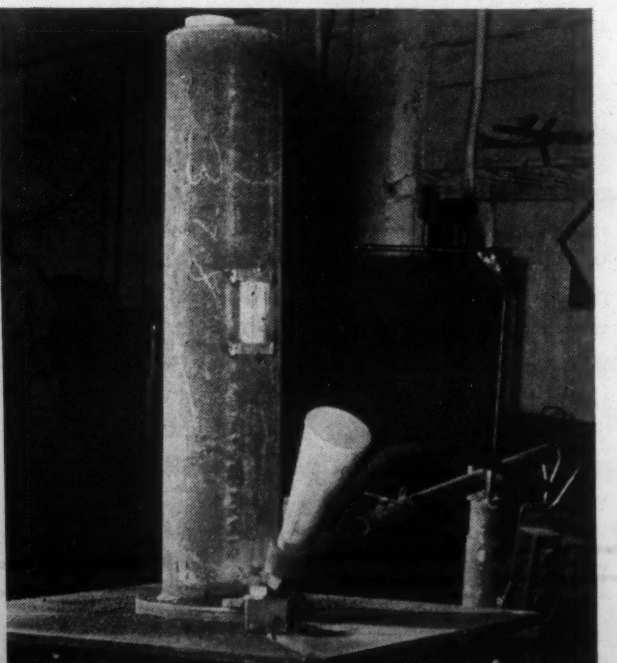
Despite its simplicity in construction and appearance, the welder is quite versatile. It can be used manually to weld irregular or inaccessible locations, thus giving it a utility of its own. By mounting the welding gun on a device to provide means of following the line of the weld, or by fastening the welding gun and moving the work past it to produce the same result, the manual welder becomes in effect a submerged arc welding machine. When the line of the weld is a true circle it is frequently convenient to mount the welding gun in a fixed position and to revolve the work past it. Straight welds can be made by moving the work past the welding head, as on a slow-moving planer table, or by moving the welding head along the line of the weld on rails or ways. For irregular welds it will usually be simplest to use the welder manually.

Typical Applications

A steel reaction tank is being made for the chemical industry by welding a head, of 1-in. stock, onto a steel cylinder made of 15/16-in. plate. After fabrication of the steel shell the

The operator is welding formed steel to fabricate a bolster for trolley car underframes. Center sill weldments are shown at the lower right.

Four passes are required to weld the head to the shell in this high-pressure chemical reaction tower. These welds must pass X-ray examination.



By using the revolving table of a standard positioner, a cylindrical steel shell is welded automatically to a flange.

interior is coated with glass by applying a glass frit and sintering. A difficulty in the past has been the release of hydrogen from the weld metal during the sintering of the glass coating. The weld is now made in two passes, one inside and one outside, using the submerged arc process with the new hand welder. Hydrogen inclusion in the weld metal is minimized because the flux is inorganic and completely shields the weld as it is made and cools. Metal is laid down from a 5/64 in. wire, with 600-amp. current.

The setup used here is interesting also. With the axis of the tank horizontal, the operator takes his position on a board that is held rigidly, cantilever style, outside the tank, and holds the welder in the line of the weld for the inside seam. The board so held permits him to stay clear of the tank while still being at the bottom of the tank. The shell is then revolved by rollers with which its outside surface is in contact, and the weld is completed as the tank moves by the operator.

When a plain butt weld was to be made in ½-in. plate, with no quantity requirement to justify an automatic setup, the welder was used manually to join the steel with one pass on each side, securing 100% penetration. The plates were butted together without scarfing, effecting a saving in cost of preparation of the work. Another saving was made in the increased welding speed possible with the submerged arc welder. The weld was made with 5/64-in. wire, with the machine set at 450 amp. Travel speed of the welder was at the rate of 22 in. per min.

Welding the steel head into a heat exchanger shell of cylindrical form was the job to which the manual submerged arc welder was assigned in another project. Here a standard Ransome positioner was used to rotate the work past a stationary welding head. A saving of 80% in welding time was reported over the arc welding by which this piece had formerly been made. An additional saving was reported through the ease of changing setups from these pieces to other work.

Heavy under frame members for trolley cars are built up by welding formed steel. Long irregular welds are made in the pieces, and these are best suited to manual operation. Use of the heavy currents and one-pass welding of the submerged arc process are made possible on this job by the manual equipment for this welding method.

A steel tower for the chemical industry is made by welding a head to a cylindrical shell. Welds are made from inside the tower, and the edges are flame-gouged. Four passes are required to lay down a satisfactory bead for this high-pressure vessel, for which X-ray examination is required. The submerged arc process deposits weld metal that is dense and free from hydrogen, so that cracking and porosity are reduced. Operating at 400 amp., the bead is laid down at a speed of 14 in. per min. A device used in this installation makes use of strong suction to remove the excess flux after the weld metal has cooled. The flux breaks away freely from the metal after cooling.

Materials & Methods Manual

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This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application

Coloring of Metals

by N. Bruce Bagger, Associate Editor, Materials & Methods

Chemical and electrolytic films are available in great variety for coloring the common engineering metals. These films can be used to advantage for many different applications and provide a wide range of colors from which a satisfactory selection can be made. Their limitations, of course, prevent indiscriminant use, but when intelligently applied to the jobs for which they are intended, they offer an excellent means of improving product appearance and utility.

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MATERIALS & METHODS MANUAL 50

Introduction

The stimulus of color has been long-accredited as an influential factor in the life and behavior of man; its attraction and allure has been felt through countless ages. Proof of its ancient strength of appeal is evidenced by the remains of now-vanished civilizations that are displayed in museums throughout the world. Shards of pottery, beads, crude tools, and implements from by-gone eras bear silent testimony to the impact that color had on the lives of these early people. But the colors were not always used for decoration alone. Oftentimes, sheer necessity required the use of certain coatings, dyes or materials on objects for added resistance to wear, waterproofing, etc. These coatings, usually colored, actually served a two-fold purpose: utility and appearance. And conditions much the same hold true today.

The myriad products produced by present-day industry are finished for many and varied reasons. Chief among these, but not necessarily in order, are: appearance, increased utility, abrasion and corrosion resistance, heat and light reflectivity or absorption, and the like. The finishes and techniques used to achieve these ends are equally varied, and most often two or more of these end results are desired in a single finish. Thus, the products are enhanced from an aesthetic and a practical standpoint, both of which contribute materially to the desirability and ultimate saleability of the item in question.

Metal coloring and finishing methods are normally considered to comprise four distinct types: mechanical, organic, chemical, and electrolytic. Because of space limitations, this particular discussion is concerned only with the latter two: the colored finishes applied by chemical immersion or spray; and the colored, electrolytically-formed finishes applied by baths. Although electrolytic finishes are commonly considered to include the deposition of a metallic coating or plate on a base metal, such has not been made a part of this discussion since, strictly speaking, the deposition of one metal to the surface of another is not a coloring procedure, even though the appearance of the base metal is changed to the appearance of the metal being deposited. In this connection, it might be well to explain that the word "coloring" as used herein pertains to actual colors of the spectrum that can be formed on the surface of metals after a given treatment. It should not be confused with the so-called "coloring" operation usually performed by mechanical means such as buffing or polishing on plated or untreated metals to bring out the natural "color" or inherent beauty of the metal surface by removing such imperfections as lines, scratches, pits, etc.

There are many films available for imparting color to metal surfaces. The selection of the proper film and color for a given application depends to a very great extent upon the properties that are desired in the finished part. Some films are naturally more resistant to wear or abrasion, while others may have greater corrosion-resistant characteristics.

The colors that are available also vary widely, and range through many different hues. In many cases, the color obtained is a function of immersion time or temperature and can be controlled accurately to a given stopping point; in others, only a single color is produced which can be varied only in depth and tone.

Sometimes the color of the film that is formed is of insufficient intensity or scope for a particular product appplication. In cases such as this, the film can be dyed to virtually any color in the spectrum. The proprietary "Alumilite" finish for aluminum and its alloys is an example of this; the neutral-colored oxide film being dyed and subsequently sealed to produce a wide variety of brilliant, translucent hues.

The type of mechanical finish on the underlying metal will, in most cases, govern the final appearance of the colored coating. Thus, articles that are highly polished before coloring will have a similar polished appearance after the color has been applied; others that were left unsmoothed or given a roughening treatment will have a dull or matte finish after coloring. Similarly, brushed, mottled, high-lighted, or satin-finished effects are possible for striking and contrasting results.

In general, the degree of corrosion resistance obtainable with these various coatings is limited at best. Most of the color films are only suitable for exposure to mildly corrosive conditions. But their corrosion resistance can be enhanced considerably by a supplemental waxing, oiling or lacquering process, which also tends to improve the luster and sheen of the finished part.

Chemical and electrolytic coatings have earned a definite production role by virtue of their economical application, appearance and corrosion protection, limited though the latter may be. They are used primarily for parts requiring contrast coloring and identification, a small degree of corrosion resistance, a comparatively wear resistant surface, and where dimensional tolerances are very close.

Iron and Steel

As a general rule, most iron and steel objects usually present a much more attractive appearance when colored than when left in the natural state. In recognition of this fact, and completely aside from any corrosion resistant qualities that may be obtained, many manufacturers utilize chemical or electrolytic color coatings on their products for reasons of saleability, appearance, and such. A major exception to this, of course, is stainless steel. Here, the durability and natural beauty of the metal itself and the variety of mechanical finishes that can be obtained on it by such means as burnishing, brushing, tumbling and polishing often leave little to be desired in a finished surface. In fact, the question of coloring this already-attractive material raises considerable stir in some quarters and gives rise, not entirely without provocation, to charges of "gilding the lily" by those to whom the natural silvery whiteness of the metal is most attractive. However, where necessity dictates, stainless steel can also be given a wide variety of colors to meet decorative or practical needs.

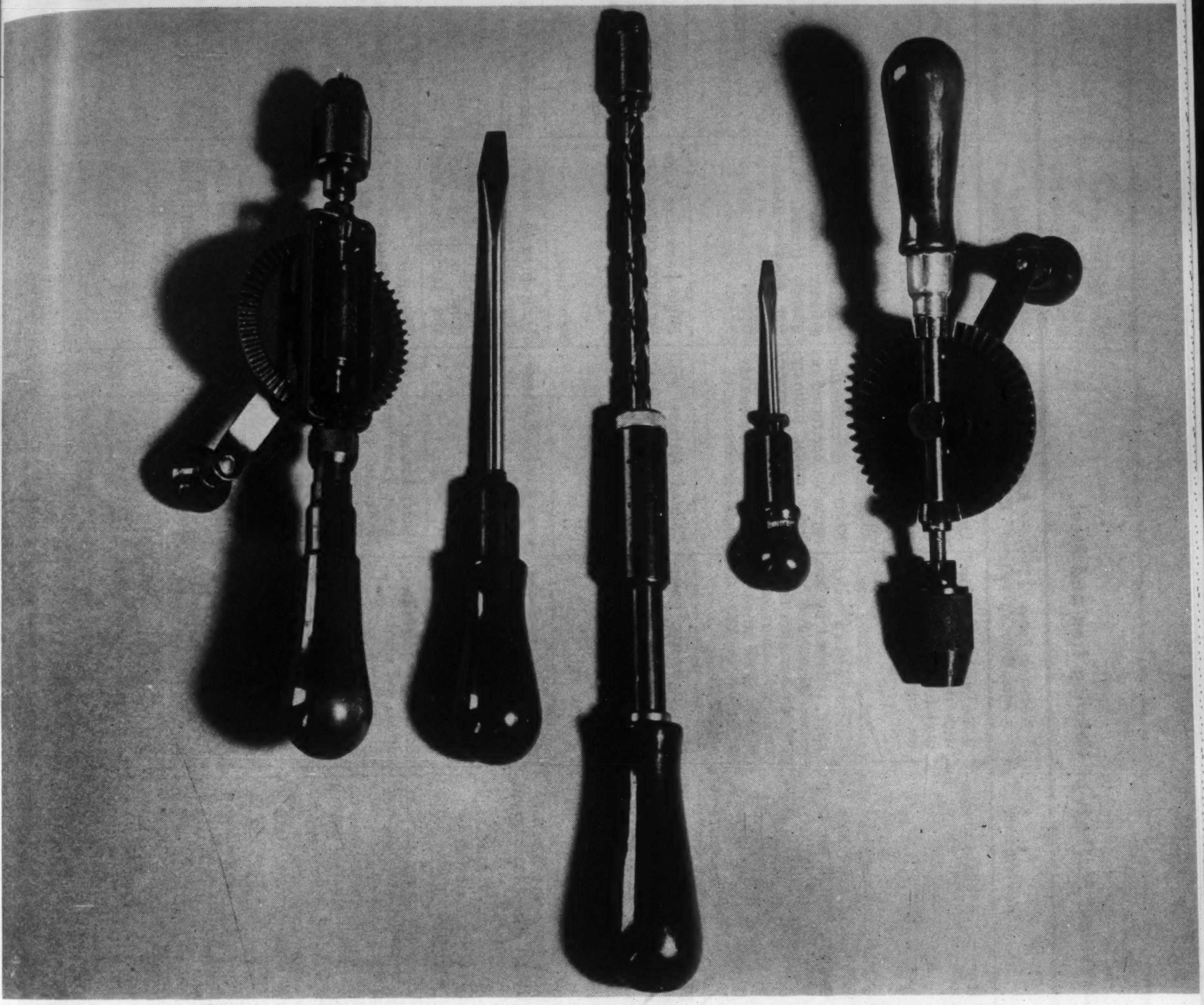
Iron and steel can be colored in several different ways. The method enjoying most common usage, however, involves the immersion of the object being colored in an aqueous alkaline oxidizing solution at elevated temperatures. There are several proprietary solutions of this type available.

Although most unalloyed ferrous metals are usually colored satisfactorily in the aqueous alkaline solutions, the ferrous alloys, which naturally include the stainless steels, are unaffected for the most part by them. By the same token, the standard coloring baths used for alloy steels usually have little effect on the unalloyed or low alloy metals. The reason for this lies in the fact that such solutions must contain relatively high concentrations of sulfuric acid; about 50% by weight of water used. Although this acid is the primary oxidizing agent in stainless steel coloring formulas, certain additions must be made to the bath to inhibit surface dissolution of the alloy being processed.

In both the low and high alloy groups, the elements present in the composition and their percentages have a great influence on the number of color films which can be produced. Austenitic alloy steels containing nickel as well as chromium permit a wide range of coloration. Within customary time cycles, alloys of this group will acquire a sequence of colors. These colors first appear as light grey, which with continued submersion, deepen to a dense black; then to deep blue, on to the bronze yellows; then to a deep "chocolate" brown, followed by maroons and brass-golds, and then through the bronzes to an end-color closely approximating chrome green.

More complex types of ferrous alloys containing varying amounts of such elements as manganese, vanadium, molybdenum or tungsten produce vivid reds, blues, an off-shade violet and various brown-yellows.

Straight chromium steels, with a chromium content varying from 7 to 22%, are likewise capable of producing a variety of colors under certain definite time cycles. These colors are in the same order of



Steel tool parts blackened by immersion process. Blackened surfaces will withstand exceptionally high temperatures but are somewhat limited in corrosion resistance. (Courtesy E. F. Houghton & Co.)

appearance as those for the austenitic alloy steels containing nickel as well as chromium, but whereas in the austenitic group the colors ranged all the way through to a chrome green, the end-color in the straight chromium steels appears as the deep "chocolate" brown. The end-color is usually the heaviest film possible to obtain.

Another method of coloring iron and steel consists of heating the metal to the desired temperature and holding it there for a definite period of time. As the material is heated gradually through a range of temperatures, each temperature produces a certain shade or hue. These colors, of course, will vary with the composition of the material in question, and range from a straw yellow through brown and purple to dark blue. However, the colors produced by this method are not always uniform, and considerable skill and experience must be utilized to obtain satisfactory results.

Colors produced by the so-called "color-plating" process are characterized by a metallic luster and are not only free from dyes and pigments, but are lightfast as well. In this method, virtually all the colors of the spectrum from violet to red can be produced in a single bath. The colors that are obtained depend on the thickness of the deposit which, in turn, is a function of the plating time. The bath for this process is composed of complex organic compounds. The object being colored is made cathodic, and copper is used as the anode. The current density is approximately 0.5 amp. per sq. ft., and the voltage is in the order of 0.4.

In general, the physical characteristics of the films that can be formed on iron and steel are excellent. Chipping, peeling or crazing is minimized since the films are fully integral with the surface of the metal and the ductility is the same as that of the specimen piece. The films do not, however, give protection against corrosion to any great extent. The reason for this lies in the fact that continuous coatings are extremely difficult to achieve.

This continuity or impermeability of the color film depends in large measure on the finish given the base metal prior to coloring. Films applied to high planish, cold-rolled surfaces usually are fully continuous and serve as effective barriers against attack by atmospheric corrosion. Iron and steel surfaces that have been roughened by grit-blasting, acid-pickling or electrolytic etching show a correspondingly reduced continuity of color film, but even such reduced continuity offers adequate resistance to corrosion for most purposes without subsequent use of organic finishes.

Color films on steel are not completely practicable for all applications common to the steel itself. This is particularly true with respect to strong abrasive attack. For service under severely abrasive conditions, a supplemental heating of short duration often produces effective dehydration of the film. This heating tends to increase the abrasive resistance of the film considerably and results in only a slight loss of original color.

Several typical methods of coloring iron and steel are listed in Table I.

Table I—Typical Methods of Coloring Iron and Steel

Color Obtained	Trade Name of Process	Manufacturer	Type of Process	Treatment Required Prior to Coloring	Coloring Procedure	Treatment Required After Coloring	Advantages of Coloring Process	Limitations of Coloring Process	Applications
Black	"Ebonol S"	Enthone, Inc., New Haven, Conn.	Dip	Immerse in alkaline cleaner, then remove rust or scale in hydrochloric acid or sulfuric acid pickles.	Immerse in blackening solution (285-290 F) for 5-25 min.	Rinse and dry. Coat with oil, wax or lacquer for outdoor service conditions.	Uniform and adherent film. Withstands severe deformation, cannot be made to flake. Requires minimum amount of equipment.	Not recommended for outdoor use unless protected by oils, lacquers or waxes. *Not suitable for coloring stainless steel.*	Hardware, locks, pulleys, machine parts, appliances, firearms, etc.
Black	"Houghto-Black"	E. F. Houghton & Co., Philadelphia, Pa.	Dip	Alkaline cleaning at 180 F followed by hot water rinse. Rust or scale removed by sulfuric acid pickle at 120 F or by cold muriatic acid pickle.	Immerse in blackening solution at 290 F for 10-30 min.	Cold running water rinse, followed by hot water rinse. For increased corrosion resistance, an immersion in a light grade rust preventive is recommended.	No large investment in specially-constructed or lined tanks; ordinary steel tanks satisfactory; colored areas will withstand exceptionally high temperatures.	Limited corrosion resistance unless subsequently treated. Will *not blacken stainless steel.*	Hardware, machine parts, ornaments, tools, etc.
Black	"Houghto-Black SS"	E. F. Houghton & Co., Philadelphia, Pa.	Dip	Alkaline cleaning at 180 F followed by hot water rinse. Scale removed by sulfuric acid pickle at 120 F or by cold muriatic acid pickle.	Immerse in blackening solution at 650 F for 10-30 min.	Cold running water rinse followed by hot water rinse.	Colored surfaces will withstand exceptionally high temperatures.	High processing temperatures required. *Recommended only for stainless steel.*	Armament, hardware, tools, fittings, and decorative applications, etc.
Black	—	—	Heat and quench	—	Heat work quickly to 1000-1200 F and quench in oil.	Appearance of color depends upon surface of work prior to heating.	Economical and reasonably fast.	Difficult to obtain uniform colors on different items. Finish is inferior to gun-metal finish, both in color and lasting qualities.	Hardware, tools, etc.
Black, Gray, Blue, Purple, Green, Olive Drab	"Endurion"	Parker Rust Proof Co., Detroit, Mich.	Dip	Parts must be Parkerized before being colored. Chromic acid dip, customary in Parkerizing process, omitted.	After Parkerizing, parts are water-rinsed and immersed in aqueous color bath without drying. Immersion period in color bath normally from 2-6 min.	Parts are water-rinsed, dried, and oiled.	Finish does not spot or darken from handling. Because of required preliminary Parkerizing, parts are resistant to severe atmospheric corrosion.	Preliminary Parkerizing required adds another step to the coloring process. With all colors, except gray, there is some tendency toward fading. But no reduction in corrosion resistance.	Bolts, nuts, screws, castings, stampings or fabricated mechanical parts.
Blue-Black	"Black-Magic"	Mitchell-Bradford Chemical Co., Stratford, Conn.	Dip	Immerse in hot alkali cleaner (180 F) for 5 min. and rinse in clean hot water.	Immerse in blackening solution, boiling at 300 F, for from 5-15 min., depending upon depth of color or penetration desired.	Rinse in cold water and immerse in boiling solution of soluble oil. For maximum corrosion resistance, omit soluble oil dip, and coat instead with a wax base compound or a water displacing oil.	Only single bath required. Minimum equipment required.	Will *not blacken stainless steel.* Recommended only for mildly corrosive conditions.	All hardware, tools, fittings and jigs, etc.
Blue	—	—	Heat	Work must have highly polished surface for optimum results.	Place highly polished work in deep bed of hot charcoal until desired shade of blue is obtained.	After desired shade of blue is obtained, polish with raw sperm oil.	Economical and reasonably fast.	Difficult to obtain uniform colors on different items.	Hardware, ornaments, etc.

Gun-Metal (Carbonia Finish)	—	—	Heat	Clean work thoroughly prior to coloring.	Place work loosely in retort with charred bone and heat to 700-800 F. Cool to 650 F. Add mixture of bone and carbonia oil. Continue heat for several hours.	Dip work in sperm oil or tumble in oily cork for uniform black finish.	Good and uniform lasting finish. Can be applied to nitrided articles.	Unable to prevent rust, but will retard its formation.	Firearms, buckles, fins, chain links, office machinery, etc.
Brown	—	—	Brush, sponge, or dip	Clean work thoroughly prior to coloring. Dry and cool to approx. 120 F.	Coat work evenly with typical browning solution: 2.8 ferric chloride, 1.5 ferrous sulfate, 8.5 nitric acid, 3.2 alcohol, and 84.0% water. Dry work 30 min., apply second coat of solution. Dry again for 30 min. Heat to 140-175 F, then transfer to high humidity cabinet to induce rusting. Place rusted metal in boiling water for 15 min. Drain dry and card on wire wheel to remove excess oxide. Repeat entire process 3 more times.	Coat finished surfaces with thin, white slushing oil.	Even and uniform coating suitable for high production run items.	Considerable investment in equipment and time involved.	Sporting goods, hardware, fixtures, fittings, etc.
Pale Yellow, Yellow, Deep Yellow, Bronze, Peacock Blue, Full Blue, Light Blue	—	—	Heat tint	Steel must be thoroughly clean and dry; free from oil, grease, finger marks, etc.	Polished steel is passed through either a lead bath or salt bath at temp. ranging from 400 F for pale yellow to 640 F for light blue. In lead bath, color develops after leaving bath and coming in contact with air; in salt bath, color develops in bath.	In lead bath, color is controlled by passing through wet waste after immersion in bath.	Economical and fast process suitable for large production run items.	Considerable skill and experience needed to obtain uniform color. Care to avoid distempering steel.	Hardware, tools, fittings, fixtures, etc.
Bright Copperish Color	"Cuprodine No. 2"	American Chemical Paint Co., Ambler, Pa.	Dip	Alkaline cleaning, water rinse, pickle, water rinse.	Immerse work in solution of Cuprodine, sulfuric acid, and water at not over 150 F for 1-5 min.	Remove work from solution, rinse in clear water and dry. Coat treated work with clear varnish or lacquer.	Rapid process assuring uniform coverage and color. *Use only for carbon or mild steel.*	Limited corrosion resistance unless supplemental coating of varnish or lacquer is applied.	Dies, tools, hardware, fixtures, fittings, etc.
Bright Copperish Color	"Cuprodine No. 3"	American Chemical Paint Co., Ambler, Pa.	Dip	Alkaline cleaning followed by depassivating treatment in sulfuric acid, muriatic acid solution at 180 F for 3-5 min.	Immerse work in solution of Cuprodine No. 3 and sulfuric acid for 3-5 min. Temp. varies with steel: 170-180 F for Types 302 and 304; 190-210 F for Types 316, 321, 347 and 380.	Remove work from solution, rinse and dry.	Rapid process; fair corrosion resistance.	*Suitable only for stainless steels.*	Dies, hardware, fixtures, tools, etc.
All Colors in Spectrum	"Electrocolor"	United Chromium, Inc., New York, N. Y.	Electrolytic	Alkaline clean and acid dip. (Priming coat of cuprous oxide applied for brilliant colors.)	Work is made cathode in coloring bath. Single bath used for all colors. Color is function of thickness of deposit. Variations of technique result in spangled, crystalline patterns.	Dry work thoroughly. Lacquer coating applied.	No dyes or pigments used; no fading of color. Rapid coloring process.	Special generator or rectifier required because of low voltage used. Corrosion resistance only as good as final lacquer coating.	Decorative trim, interior automotive appointments, etc.

Table II—Typical Methods of Coloring Copper and Copper-Base Alloys

Metal	Color Obtained	Trade Name of Process	Manufacturer	Type of Process	Treatment Required Prior to Coloring	Coloring Procedure	Treatment Required After Coloring	Advantages of Coloring Process	Limitations of Coloring Process	Applications
Copper	Black	"Black-Magic"	Mitchell-Bradford Chemical Co., Stratford, Conn.	Dip	Chemical cleaning followed by cold water rinse; pickle in 25-50% solution of muriatic acid and rinse in cold water.	Immerse in blackening solution (200-218 F) for 3-5 min.	Rinse in cold water and immerse in soluble oil or tumble in sawdust. A small amount of oil added to the sawdust produces a high luster finish.	Application of finish makes no change in dimension of part. Comparatively low temperature of coloring bath will not soften or harden the thinnest metal.	Suitable only for exposure to mildly corrosive atmospheres.	Fixtures, jigs, hardware, decorative applications, etc.
	Black	"Ebonol C"	Enthone, Inc., New Haven, Conn.	Dip	Alkali cleaning then bright-dipped in a sulfuric-nitric acid bright dip. If parts are buffed, bright dipping is not necessary.	Immerse briefly in blackening solution (210-218 F).	Dull finish obtained by waxing dried surface; glossy finish obtained by clear lacquering or oiling.	Thermodynamically stable, does not tend to recrystallize, evolve gases or revert to other compounds.	Limited corrosion resistance unless subsequently covered with hard drying wax or oil.	Hardware, tools, decorative applications, etc.
	Black	—	—	Dip	Hot alkaline cleaner, cold water rinse; cyanide dip, cold water rinse.	Immerse in a water solution of potassium sulfide (100 F) for 5-10 sec.	Rinse in cold and hot water; dry by air blast; coat with clear nitrocellulose lacquer.	Rapid coloring; extremely high gloss resulting from lacquer topping.	Limited resistance to severe corrosion.	Ornaments, interior decorative purposes, costume jewelry, etc.
	Blue-green	"Cabra" spray process	Developed by Copper & Brass Research Assn., New York, N. Y.	Spray	Removal of all dirt, oil, grease with trisodium phosphate; rinse. If an oxide film is present, remove by swabbing with 5-10% sulfuric acid; rinse with clean water.	Spray on water solution of ammonium sulfate, copper sulfate and concentrated ammonia. Spraying and drying are repeated 5 or 6 times.	Exposure to conditions of high atmospheric moisture necessary for development of color.	Suitable for coloring large areas of work.	Close control of post-coloring conditions extremely important. Careful mixing of coloring solution necessary. Process time-consuming.	Roofs, doors, statuary, etc., and other large-sized objects subjected to exterior service conditions.
	Dark red	—	—	Dip	Hot alkaline cleaner, cold water rinse; cyanide dip, cold water rinse. Dry by air blast.	Immerse in molten potassium nitrate (1200-1300 F) for 20 sec. Quench in hot water.	Dry by air blast and buff surface. Coat with clear nitrocellulose lacquer.	Rapid coloring; extremely high gloss resulting from lacquer topping.	Limited resistance to severe corrosion. High temperatures necessary for coloring operation.	Ornaments, interior decorative purposes, costume jewelry, etc.
Copper and Brass	All colors in spectrum	"Electro-color"	United Chromium, Inc., New York, N. Y.	Electrolytic	Alkaline clean and acid dip. (Priming coat of cuprous oxide applied for briliant colors.)	Work is made cathode in coloring bath. Single bath used for all colors. Color is function of thickness of deposit. Variations of technique result in a spangled crystalline pattern.	Dry work thoroughly. Lacquering always required.	No dyes or pigments used, hence no fading of color. Rapid coloring process.	Special generator or rectifier required because of low voltage used. Corrosion resistance only as good as lacquer coating.	Decorative trim, interior automotive appointments, etc.
	Antique green (oxidized effect)	—	—	Dip or brush	Chemical cleaning followed by cold water rinse.	Immerse in water solution of iron chloride, sal ammoniac, verdigris powder, common salt, and cream of tartar. For brush application, merely paint solution on.	After immersion or brushing, stipple with soft round brush to give variegated appearance of naturally-aged bronze.	Adapted to large surfaces; opportunity for unique appearance through application of artistic skill.	Certain degree of artistic skill required for stippled effects.	Statuary, decorative and architectural applications, etc.

Copper and Brass	Verde antique	—	—	Dip or stipple	Chemical cleaning followed by cold water rinse.	Immerse in water solution of sal ammoniac, calcium chloride, and nitrate of copper. For stipple application, add carbonate of copper to solution to form a paste. Use stiff bristle rubberset brush.	Finish should be dull lacquered for added corrosion resistance. Waxing over lacquer often used.	Adapted to large surfaces. Finish quickly obtained. Opportunity for unique appearance through application of artistic skill.	Considerable equipment and skill required, particularly for stippled effects.	Statuary, decorative and architectural applications, etc.
	Brown, reddish bronze, and blue-black	—	—	Dip	Chemical cleaning followed by cold water rinse.	Immerse in water solution of potassium sulfuret and caustic soda (160-180 F). Colors develop in following order: brown, reddish-bronze, bluish-black, and black. Remove when desired tone is reached.	Wash thoroughly in cold water. Scouring with pumice and water or oil helps to bring out certain tones. Scratch brushing develops additional color tones.	More widespread color choice with but a single bath. Variegated appearances possible through subsequent scouring and brushing operations.	Difficulty in matching colors, tones, surface finishes, etc.	Statuary, decorative and architectural applications, etc.
Brass	Black	—	—	Dip	Chemical cleaning followed by cold water rinse.	Immerse in water solution of copper carbonate, 2% ammonia water, and crystal sal soda (150 F) for a few sec.	Rinse thoroughly in hot water and dry.	Works best with common brass, either leaded or non-leaded.	Not suitable for copper or copper-alloys containing above 85% copper. Surface must be exceptionally clean.	Ornaments, fittings, trim, decorative and architectural purposes.
	Black	"Black-Magic"	Mitchell-Bradford Chemical Co., Stratford, Conn.	Dip	Chemical cleaning followed by cold water rinse; pickle in 25-50% solution of muriatic acid and rinse in cold water.	Immerse in blackening solution (200-218 F) for 10-20 min.	Rinse in cold water and immerse in soluble oil or tumble in sawdust. Small amount of oil added to sawdust produces a high luster finish.	Application of finish makes no change in direction of part. Comparatively low temp. of cooling bath will not soften or harden the thinnest metal.	Suitable only for exposure to mildly corrosive conditions.	Fixtures, jigs, hardware, decorative applications, etc.
	Black	—	—	Dip	Hot alkaline cleaner, cold water rinse; cyanide dip, cold water rinse.	Suspend in hot caustic soda solution for a few min.; then immerse in hot caustic solution to which potassium persulfate has been added and heated to incipient boiling. Immerse for 10 min.	Rinse thoroughly in cold and hot water; dry by air blast; smooth surface by rubbing with soft, clean cloth, coat with clear lacquer.	Dense black, velvet-like film formed.	Impractical for large surfaces.	Decorative and architectural applications, etc.
	Black	"Ebonol C Special"	Enthone, Inc., New Haven, Conn.	Dip	Hot alkaline cleaning, rinse with cold running water, bright dip with sulfuric-nitric acid; rinse with cold running water.	Immerse brass in Enthone activating solution approx. 2 min. Rinse in cold water and dip in blackening solution at 219-220 F.	Rinse thoroughly and dry. Wax, oil, or lacquer for high glossy finish.	Good for copper alloys containing less than 90% copper. Activating solution not needed for alloys containing better than 90% copper.	Requires standard processing time and equipment.	Decorative and architectural applications, etc.
	Blue-black	—	—	Dip	Hot alkaline cleaner, cold water rinse; cyanide dip, cold water rinse.	Immerse in water solution of copper carbonate and ammonium hydroxide (180-200 F) for approximately 10 sec.	Cold water rinse, alkaline rinse; cold water rinse, alcohol rinse, dry in clean sawdust and coat with clear nitrocellulose lacquer.	Rapid color-forming technique.	Complex rinsing operations after coloring; limited resistance to severe corrosion.	Decorative and architectural applications, etc.
	Steel gray	—	—	Dip	Hot alkaline cleaner, cold water rinse; cyanide dip, cold water rinse.	Immerse in water solution of arsenic trioxide, hydrochloric acid, and sulfuric acid (70 F) for 5-10 sec.	Cold and hot water rinses; dry by air blast; coat with clear nitrocellulose lacquer.	Rapid color-forming method.	Limited resistance to corrosion.	Decorative and architectural applications, etc.

(Continued on page 74)

Copper and Copper-Base Alloys (continued)

Metal	Color Obtained	Trade Name of Process	Manufacturer	Type of Process	Treatment Required Prior to Coloring	Coloring Procedure	Treatment Required After Coloring	Advantages of Coloring Process	Limitations of Coloring Process	Applications
Brass	Brown	—	—	Dip	Hot alkaline cleaner followed by cold water rinse; cyanide dip, cold water rinse.	Immerse in water solution of sodium bichromate, nitric acid, hydrochloric acid and wetting agent (70 F) for 1 min. Agitate work at 15-sec. intervals.	Rinse in cold and hot water; dry by air blast; coat with a clear nitrocellulose lacquer.	Film easily removed when wet; after drying it is very adherent if properly applied.	Limited resistance to severe corrosion.	Statuary, decorative and architectural applications, etc.
	Brown	—	—	Dip	Chemical cleaning followed by cold water rinse.	Immerse in water solution of copper sulfate and potassium chlorate for 1 min. Without rinsing, immerse briefly in water solution of liver of sulfur. Rinse in cold water and repeat dipping operation until desired color is obtained.	Rinse in hot water, dry in hot sawdust or in air blast; scratch brush with fine wire wheel and coat with clear lacquer.	Great variety of tonal depths available, depending on number of successive immersions in baths.	Considerable effort needed to obtain most satisfactory finish; multiple dipping and subsequent brushing, etc.	Decorative and architectural applications, etc.
	Old English finish (light brown)	—	—	Dip	Chemical cleaning followed by cold water rinse.	Immerse in water solution of liver of sulfur; then without rinsing immerse in water solution of copper sulfate; rinse in cold water and repeat dipping operations until light color is produced.	Rinse in hot and cold water; dry in sawdust; scratch brush on fine wire wheel and then coat with clear lacquer.	Great variety of tonal depths available, depending on number of successive immersions in baths.	Considerable effort needed to obtain most satisfactory finish; multiple dipping and subsequent brushing, etc.	Decorative and architectural applications, etc.
	Statuary bronze	—	—	Dip	Hot alkaline cleaner, cold water rinse; cyanide dip, cold water rinse.	Immerse in water solution of copper carbonate and ammonium hydroxide (180-200 F) for approx. 10 sec. Then cold water rinse, and immerse in solution of dilute sulfuric acid.	Rinse thoroughly in cold water; dry by air blast; remove smut with clean soft rag or sawdust; coat with clear lacquer.	Great variety of tonal depths available, depending on number of successive immersions in baths.	Considerable effort needed to obtain most satisfactory finish; multiple dipping and subsequent finishing, etc.	Decorative and architectural applications, etc.
	Gold	—	—	Dip	Hot alkaline cleaner, cold water rinse; cyanide dip, cold water rinse.	Immerse in water solution of sodium bichromate, nitric acid, hydrochloric acid, sulfuric acid and wetting agent (70 F) for 1 min. Agitate work every 15-sec.	Rinse in cold and hot water; dry by air blast; coat with clear nitrocellulose lacquer.	Film is easily removed when wet; after drying is very adherent if properly applied.	Limited resistance to corrosion.	Decorative and architectural applications, etc.
	Green	—	—	Dip	Polish with emery cloth to a fine surface and chemically clean.	Immerse in water solution of nitrate of iron and hyposulfite of soda (180 F) until greenish tone appears.	Wash off thoroughly in water and touch up high lights with Tampico brush or wheel and fine brimstone and water.	Produces a durable and corrosion resistant color suitable for outdoor exposure.	Not very practicable for large surfaces. Certain degree of artistic skill required in touch-up operation.	Hardware, ornaments, fittings, etc.
	Light green	—	—	Dip	Hot alkaline cleaner, cold water rinse; cyanide dip, cold water rinse.	Immerse in water solution of sodium bichromate, phosphoric acid and wetting agent for 10-15 min.	Rinse in hot and cold water; dry by air blast; coat with clear nitrocellulose lacquer.	Film easily removed when wet; after drying it is very adherent if properly applied.	Limited resistance to severe corrosion.	Decorative and architectural applications, etc.
	Gold, blue, blue-green, peacock, green-brown, and brown	"Ebonol C"	Enthone, Inc., New Haven, Conn.	Dip	Cleaning in nontarnishing alkali cleaner followed by thorough rinsing.	Immerse in coloring solution (150-200 F). Color obtained is dependent upon immersion time. 15 sec. for gold; 30 sec. for blue; 2 min. for brown; etc.	Thorough rinsing, then dried and lacquered.	Colors very adherent, will not flake. Stable chemically to indoor atmospheres. Do not crystal-spot or fade.	Limited resistance to severe corrosion. Must be lacquered for long life and protection against mechanical wear.	Lamps, lighting fixtures, hardware, buttons, fasteners, screens, etc.

Copper and Its Alloys

Copper and its alloys, possessed of an attractive natural appearance, are often left in the untreated or unfinished state. Under exposed conditions, the beautiful effects resulting from time and weathering are often sufficient to obviate the need for further finishing, but under most commercial applications, certain coloring techniques are ordinarily used.

There is a wide range of colors and shades which can be given to copper and copper-base alloys. Virtually all of these colors are a function of the skill with which they are applied. The time of immersion in the coloring solution, the temperature of the bath, the composition of the alloy, and other such variable factors materially affect the success of the operation.

The composition of the alloy is of extreme importance in obtaining a satisfactory color. Alloys high in copper content usually take on much different hues than do alloys that are low in copper, even when subjected to the same treatment. For this reason, extreme care and a liberal use of test specimens is recommended before large-scale coloring is undertaken.

The formation of cupric oxide coatings which are extremely adherent and which give good protection to the base metal are used extensively where either bright or dull finishes are desired. The corrosion protection afforded to most copper alloys with unoiled coatings of this type is approximately 25 hr. in salt spray, and they are used where heat absorption, reflection, or radiation is to be controlled on the metal surfaces.

Oxide finishes are well suited as paint bases for copper alloys, particularly brass. Since it is usually difficult to achieve permanent adhesion of lacquers or paints to brass, the oxide coating satisfactorily enables such finishes to be applied should they be subsequently desired. Oxide coatings have good heat stability and do not decompose or spot.

Several methods are used to apply cupric oxide coatings. In one, the metal is heated with copper nitrate in nitric acid; in another, the familiar copper carbonate ammonia solution is used, but the dark-bluish coating that results on brass and certain copper alloys by this method does not contribute much to corrosion resistance. Electrolytic methods involving reverse current and a caustic soda solution are used in some cases, and chemical oxidizing solutions are available for producing coatings at boiling water temperatures in a few minutes.

Oxide color films formed on copper by direct oxidation of the base metal are extremely adherent. They will not flake, are chemically stable indoors, and possess a depth not possibly obtainable by colored lacquers.

As in the case of other metals, where chemical coloring methods are used, only a thin layer of chemical compound is produced on the surface of the metal being colored. In this connection, copper is no exception. Because the coloring layer is very thin, the character of the finish immediately under it is likely to show clearly. Thus, the physical condition of the metal surface often determines what surface treatment is to be given the base metal before coloring it to obtain the desired effects.

Several typical methods of coloring copper and copper-base alloys are listed in Table II.

Steel armament, tool and machine parts blackened by immersion. Subsequent waxing or oiling improves surface appearance and increases corrosion resistance. (Courtesy Mitchell-Bradford Chemical Co.)

Cadmium and Zinc

Cadmium, zinc and zinc-base alloys are normally considered to be corrosion resistant materials. In ordinary atmospheres they do not corrode rapidly, but a grayish tone is formed on the surface which, for many applications, is unsuitable as it mars the otherwise smooth surface and silvery white color of the natural metal. In cases where the metal is exposed to stagnant moisture or condensation with limited access to oxygen, corrosion of a non-uniform type occurs which often results in the formation of a bulky white film on the surface of the metal.

To prevent or minimize this tendency and at the same time provide an attractive variety of colored finishes without recourse to organic or plated coatings, several proprietary treatments have been developed. Most of these are simple chemical dip or immersion applications and require little specialized equipment. In others, baths and cathodes are used and the work is made anodic. Low current densities are utilized and finishing times are usually only a matter of a few minutes.

The direct oxidation of zinc to an oxide

Table III—Typical Methods of Coloring Cadmium, Zinc and Zinc-Base Alloys

Metal	Color Obtained	Trade Name of Process	Manufacturer	Type of Process	Treatment Required Prior to Coloring	Coloring Procedure	Treatment Required After Coloring	Advantages of Coloring Process	Limitations of Coloring Process	Applications
Zinc and Zinc-Base Alloys	Iridescent golden brown	"Chronak"	New Jersey Zinc Co., New York, N. Y.	Dip	Chemical cleaning to remove wax, oil, dirt or grease.	Immerse part in acidified solution of sodium dichromate for a few seconds.	Rinse in cool water and blow dry.	Ability to heal zinc areas which are bared accidentally. Prevents non-uniform corrosion resulting from exposure to stagnant moisture or to condensation with limited access to oxygen.	Adds nothing to life of zinc. Not a substitute for an adequate thickness of zinc. Not applicable to zinc-iron alloys with Sherardized coatings on an alloy layer portion of hot dip zinc coatings.	Lock parts, fuel valves, gages, carburetors, gasoline drums, meter parts, governors, telephone parts, air compressors, etc.
	Iridescent brassy-yellow or dark black	"Anozinc"	United Chromium, Inc., New York, N. Y.	Electrolytic	Conventional cleaning cycle used before treatment.	Bath operated at room temp. in unlined steel tank. Steel cathodes used, work is made anodic at about 6 v. Finish produced in 3 min.	For deep, rich black a supplementary sealing treatment is used. Waxing, oiling, or other final treatment can also be used. No aging or setting required.	Increased corrosion resistance; excellent for outdoor exposure.	More equipment is needed than with regular dip coloring processes.	For coloring zinc plated on any metal and for zinc-base die castings.
	Black or olive drab	"Unichrome"	United Chromium, Inc., New York, N. Y.	Dip	Clean to remove wax, oil, dirt and grease.	Immerse part in 60-80 F mixture of water and compound.	Dry by blower or centrifuge.	Good protection against corrosion; prevents formation of white corrosion products; retains original luster. No filtering, agitating, or ventilating equipment required.	—	Hardware, tools, fittings, etc.
	Black	"Ebonol Z"	Enthone, Inc., New Haven, Conn.	Dip	Clean in special alkaline cleaner to activate surface; rinse.	Immerse in solution (125-180 F); time depends upon activity of zinc: 5 min. for electroplated zinc, approx. 10 min. for zinc alloys.	For parts exposed to high humidity, apply coating of hard-drying wax or oil.	Especially sintered for blackening electroplated zinc because of the small amount of zinc removed by blackening process.	Recommended only for indoor use or on those protected from the weather.	Automotive interior trim, fittings, hardware, etc.
	Iridescent gold to chocolate brown	"Zinodine"	American Chemical Paint Co., Ambler, Pa.	Dip	Mild alkaline cleaning, rinse thoroughly in cold running water.	Immerse work in Zinodine and water solution at 60-85 F for 10-30 sec.	Rinse thoroughly and dry.	Retards formation of white rust or bloom. Serves as excellent paint bond.	—	Automotive parts, fittings, etc.
	Black	"Black-Magic"	Mitchell-Bradford Chemical Co., Stratford, Conn.	Dip	Clean in any mild cleaning solution, especially recommended for zinc, and rinse. Remove any oxides by short immersion in solution of sodium cyanide, caustic soda and water.	For zinc and zinc plate, immerse in solution (70-90 F) for 20-30 min.; for zinc-base die castings, immerse in room temp. 25-50% muriatic acid, then rinse in cold water and immerse in solution (70-90 F) for 10-20 min.	Rinse thoroughly in cold water and tumble dry in sawdust to which a little oil has been added. For rust-resistance, coat with a water-displacing oil or a wax film.	Minimum of equipment required; rapid coloring.	Suitable only for exposure to mildly corrosive atmospheres; not recommended for outdoor use.	Washers, eyelets, grommets, buttons, buckles, etc.
	All colors of spectrum	"Electrocolor"	United Chromium, Inc., New York, N. Y.	Electrolytic	Alkaline clean and acid dip. (Priming coat of cuprous oxide applied for brilliant colors.)	Work is made cathode in coloring bath. Single bath used for all colors. Color is function of thickness of deposit. Variation of technique results in a spangled, crystalline pattern.	Dry work thoroughly. Lacquering is always required.	No dyes or pigments used, hence no fading of color. Rapid coloring process.	Special generator or rectifier required because of low voltage required. Corrosion resistance only as good as lacquer coating.	Decorative trim, interior automotive appointments, etc.

Zinc and Zinc-Base Alloys	Clear bright, iridescent bright, bronze, iridescent gold, and olive drab	"Iridite"	Allied Research Products, Inc., Baltimore, Md.	Dip	Chemically clean surface required.	Immerse in Iridite solution for a few seconds. A chemical, non-porous, gel-like film is generated on metal surface.	For greater abrasion resistance, lacquer coating is recommended.	Provides moderate corrosion resistance; seals metal surface.	All colors, except the clear, bright Iridite, will fade when exposed to sunlight or immersed in water.	Automotive parts, hardware, tools, fittings, kitchen utensils, wire products, machinery, ordnance materials, etc.
	Red, blue, green, black	Alizarine or Diazo dyes in conjunction with Iridite process.	Allied Research Products, Inc., Baltimore, Md.	Dip	Standard Iridite dip required prior to dye application.	Immerse wet Iridite film, before drying, in a slightly acid dye solution.	For greater abrasion resistance, lacquer coating is recommended.	Provides moderate corrosion resistance; seals metal surface.	All colors other than those applied to the clear, bright Iridite will fade when exposed to sunlight or immersed in water.	Office machines, hardware, fittings, camera parts, instruments, etc.
Cadmium	Iridescent golden brown	"Chronak"	New Jersey Zinc Co., New York, N. Y.	Dip	Chemical cleaning to remove wax, oil, dirt, and grease.	Immerse part in acidified solution of dichromate for a few seconds.	Rinse in cool water and blow dry.	Ability to heal areas that are bared accidentally. Prevents non-uniform corrosion resulting from exposure to stagnant moisture or condensation with limited access to oxygen.	Adds nothing to life of cadmium and is not to be considered a substitute for an adequate thickness of cadmium in plated parts.	Locks, valves, gages, machine and electrical parts, small hardware, etc.
	Black	"Black-Magic"	Mitchell-Bradford Chemical Co., Stratford, Conn.	Dip	Clean in alkali cleaner and rinse thoroughly in cold water.	Immerse in blackening solution heated to 120-140 F for 5-15 min. Increased temp. speeds the reaction, but 140 F should not be exceeded.	Rinse thoroughly in cold water; immerse in water displacing oil or tumble in sawdust to which a little oil has been added.	Minimum of equipment required; rapid coloring procedure.	Suitable only for exposure to mildly corrosive atmospheres; not recommended for severe outdoor use.	Hardware, eyelets, washers, grommets, buttons, buckles, fasteners, etc.
	Black and olive drab	"Unichrome"	United Chromium, Inc., New York, N. Y.	Dip	Clean to remove wax, oil, dirt and grease.	Immerse part in 60-80 F mixture of water and compound for 2-5 min.	Dry by blower or centrifuge.	Good protection against corrosion; prevents formation of white corrosion products; retains original luster. No filtering, agitating, or special ventilating equipment required.	—	Toys, machine parts, hardware, tools, fittings, etc.
	Clear bright, iridescent bright, bronze, olive drab	"Iridite"	Allied Research Products, Inc., Baltimore, Md.	Dip	Chemically clean surface required.	Immerse in Iridite solution for a few seconds. A chemical, non-porous, gel-like film is generated on metal surface.	For greater abrasion resistance, lacquer coating is recommended.	Provides moderate corrosion resistance; seals metal surface.	All colors, except the clear, bright Iridite, will fade when exposed to sunlight or immersed in water.	Automotive parts, hardware, toys, tools, fittings, kitchen utensils, etc.
	Red, blue, green, black	Alizarine or Diazo dyes in conjunction with Iridite process.	Allied Research Products, Inc., Baltimore, Md.	Dip	Standard Iridite dip required prior to dye application.	Immerse wet Iridite film, before drying, in a slightly acid dye solution.	For greater abrasion resistance, lacquer coating is recommended.	Provides moderate corrosion resistance; seals metal surface.	All colors other than those applied to the clear, bright Iridite will fade when exposed to sunlight or immersed in water.	Office machines, hardware, fittings, camera parts, instruments, etc.
	All colors of spectrum	"Electrocolor"	United Chromium, Inc., New York, N. Y.	Electrolytic	Alkaline clean and acid dip. (Priming coat of cuprous oxide applied for brilliant colors.)	Work is made cathode in coloring bath. Single bath used for all colors. Color is function of thickness of deposit. Variation of technique results in a spangled, crystalline pattern.	Dry work thoroughly. Lacquering is always required.	No dyes or pigments used, hence no fading of color. Rapid coloring process.	Special generator or rectifier required because of low voltage used. Corrosion resistance only as good as lacquer coating.	Decorative trim, interior automotive appointments, etc.
	Iridescent gold to chocolate brown	"Zinodine"	American Chemical Paint Co., Ambler, Pa.	Dip	Mild alkaline cleaning, rinse thoroughly in cold running water.	Immerse work in Zinodine and water solution at 60-85 F for 10-30 sec.	Rinse thoroughly and dry.	Retards formation of white rust or bloom. Serves as excellent paint bond if required.	—	Automotive parts, fittings, etc.

Table IV—Typical Methods of Coloring Aluminum and Aluminum Alloys

Color Obtained	Trade Name of Process	Manufacturer	Type of Process	Treatment Required Prior to Coloring	Coloring Procedure	Treatment Required After Coloring	Advantages of Coloring Process	Limitations of Coloring Process	Applications
Black	"Ebonol Z"	Enthone, Inc., New Haven, Conn.	Dip and electrolytic	Clean and immerse work in Enthone's "Alumon" solution. Work is made the cathode and steel rods the anode. Use electrical potential of 2-3 v. Continue electrolytic treatment 3-5 min. Remove work and rinse thoroughly in running water.	Immediately after electrolytic treatment in "Alumon" solution immerse work in "Ebonol Z" solution for 6-10 min.	Rinse work in running cold water then in hot water. Dry with sawdust or blow dry. Water drying on work by letting it stand may cause stains.	Produces a uniform and adherent blacking if properly applied.	Fading may result if "Ebonol Z" treatment was too short or if zinc film applied by "Alumon" treatment was too thin. A certain few aluminum alloys cannot be blackened by this method.	Decorative trim, hardware items, jewelry, etc.
Black	Alkali arsenic staining process.	—	Dip	Immerse work in a solution of sodium chloride.	Immerse in a bath of arsenious oxide, hydrochloric acid and ferrous sulfate.	Rinse thoroughly in water and dry.	Economical finish and easily applied.	Suitable only for parts destined for interior use.	Decorative trim, novelties, toys, games, etc.
Originally bluish or greenish gray, yellowish-green, black. Can be dyed all colors of spectrum by variation in procedure.	"Alrok"	Aluminum Co. of America, Pittsburgh, Pa.	Dip	Clean and immerse work in hot solution of sodium carbonate and potassium dichromate for 20 min.	Seal pores of oxide film thus formed in a hot solution of potassium dichromate or absorb water-soluble dye.	Rinse work thoroughly and dry. Colors will vary depending upon alloy treated.	Especially adapted to the bulk treatment of small parts. Economical and easy to apply. Other colors available with dyes.	Coatings usually thinner, softer, and more porous than those obtained by anodic process. Limited corrosion and abrasion resistance.	Decorative trim, hardware, toys, household goods, etc.
Originally slate gray. Can be dyed all colors of spectrum.	Modified Bauer-Vogel process.	—	Dip	Clean work thoroughly.	Immerse work in an aqueous solution of 5% sodium carbonate and 1.5% sodium chromate at 195-212 F for 3-5 min.	Rinse work thoroughly in water. Hardness and abrasion resistance can be increased by immersing in 3-5% sodium silicate solution for 15 min. (195 F).	Economical finish and easily applied. Film can be dyed all colors.	Surface film has only fair abrasion resistance and adherence.	Decorative trim, etc.
White, greenish-white	McCulloch process	—	Dip	Clean work thoroughly.	Immerse in a hot (160-212 F) solution of 1% calcium hydroxide and 1% calcium sulfate for 1 hr.	Wash work thoroughly and heat to about 390 F. If subsequently treated in a hot bath of 0.5 barium oxide and 0.5% barium sulfate, a silvery-gray film is formed on the surface.	Adapted to bulk treatment of small parts. Economically applied.	The white film is formed on commercially pure aluminum only; the greenish-white tone is formed on aluminum alloys.	Decorative trim, etc.
Originally transparent to pale-gray. Can be dyed all colors of spectrum, depending upon alloy.	"Alumilite"	Aluminum Co. of America, Pittsburgh, Pa.	Electrolytic	Degrease, or clean work thoroughly in hot, mild alkali solution, rinse in clear, cold water.	Make parts the anode in a 10-25% solution of sulfuric acid maintained at about 68-88 F. Treatment time varies from 10-60 min. at 10-24 v. d.c.	Rinse parts thoroughly in clear, cold water before sealing treatment.	Good corrosion and abrasion resistance; good absorption qualities. Can be subsequently dyed to almost any color. Finish has good dielectric strength.	Indoor use only. Metal loss by solution higher than in other processes. Patented process available under licensing arrangements from Aluminum Co. of America.	Trim, novelties, household goods, hardware, instrument components, etc.

Originally clear, transparent. Can be dyed all colors of spectrum.	Sulfamic acid process	Reynolds Metals Co., Louisville, Ky.	Electrolytic	Clean work thoroughly and rinse in clear, cold water.	Make parts the anode in a 5-10% solution of sulfamic acid maintained at about 120 F. Treatment time approx. 15 min. at 15-25 v. d.c. Current density 6-25 amp. per sq. ft.	Rinse parts thoroughly in clear, cold water.	Excellent electrical resistance; good abrasion and corrosion resistance. Can be subsequently dyed to almost any color.	Indoor use only. Voltage build-up cycle required during process. Patented process. Reynolds Metals Co.	Trim, novelties, household goods, hardware, appliances, etc.
Yellowish to brown	Oxalic acid process	—	Electrolytic	Clean work thoroughly and rinse in clear water.	Make parts the anode in a 5-10% solution of oxalic acid in temp. range 68-95 F. Treatment time approx. 20-60 min. at 60 v. d.c. or 40 v. a.c.	Rinse thoroughly in clear, cold water.	Moderately hard and abrasion resistant coating. Color of film can be varied by operating temp. and time.	High voltage required; not readily dyed.	Trim, novelties, household goods, hardware, etc.
Light yellow to dark brown (pastel shades)	Chromic acid process	—	Electrolytic	Clean work thoroughly and rinse in clear water.	Make parts the anode in a solution of chromic acid 3-5% by weight maintained at about 100-125 F. Treatment time about 1 hr. at 0.65 v. d.c. Current density 3-10 amp. per sq. ft.	Rinse thoroughly in clear, cold water, and seal dyed colors.	Very little metal loss by solution; dense, thin coating formed.	Thin films formed, about 0.0001 in. not dyed readily. High copper and silicon alloys not suitable for coating by this method.	Trim, novelties, household goods, hardware, etc.
All colors of spectrum	"Electrocolor"	United Chromium Inc., New York, N. Y.	Electrolytic	Alkaline clean and acid dip. (Priming coat of cuprous oxide applied for brilliant colors.)	Work is made cathode in coloring bath. Single bath used for all colors. Color is function of thickness of deposit. Variations of technique result in spangled, crystalline patterns.	Dry work thoroughly. Lacquering is always required.	No dyes or pigments used, hence no fading of color. Rapid coloring process.	Special generator or amplifier required because of low voltage used. Corrosion resistance only as good as lacquer coating.	Decorative trim, interior automotive appointments, etc.
Iridescent blue-green to greenish yellow	"Alodine"	American Chemical Paint Co., Ambler, Pa.	Dip	Alkaline clean and rinse.	Immerse work in Alodine bath at 120 F for approx. 2 min.	Remove work and dry thoroughly. *No sealing treatment necessary.*	Hard, adherent coating. No appreciable dimensional change. Good corrosion resistance. Withstands deformation.	—	Trim, hardware, fixtures, fittings, etc.

can be achieved by electrochemical means, but the method most generally used to apply oxide coatings to zinc utilizes special molybdate solutions to deposit an adherent black coating on the zinc. This method is used extensively in both the typewriter and button industries. The parts in question are made from either zinc-plated steel or zinc-base alloys, but in any event, are blackened by the molybdate process. Formerly, the parts were japanned or enameled, but the finish clogged orifices or interstices and resulted in high production costs because of the necessity for subsequently removing the finish from the clogged portions of the work.

The blackening of zinc-base die castings is increasing to a great extent since parts finished by this method can be buffed to high luster without destroying the finish, as is often the case with organic coatings.

Most of the coloring methods used for zinc and zinc-base alloys are applicable to cadmium with little or no change in the basic techniques involved. Immersion temperatures and times will vary slightly, but essentially the processes are the same.

The colors available through these types of treatments vary widely. In some instances, the desired color is dependent upon the length of time the metal is immersed in the coloring solution. In others, the physical condition of the metal surface prior to coloring governs the degree or intensity of the final color.

Irrespective of the ultimate colors obtained, the films themselves are often ideally suited for use as primers or bases for subsequent application of organic finishes, should such finishing methods be desired. In this connection, their sole purpose is that of sealing the metal surface and the retardation of any corrosion that might otherwise take place.

The coatings are excellent for use indoors or for exposure to mild atmospheres, but if outdoor weather or abrasive conditions are to be withstood, the finish should be protected with a subsequent application of wax, oil or clear lacquer.

Several typical methods of coloring cadmium, zinc and zinc-base alloys are listed in Table III.

Aluminum

One of the most important types of finishes applicable to aluminum is the oxide coating. This coating appears in a variety of more-or-less subdued shades and is often colorless and transparent. For this reason, the oxide films on aluminum are usually dyed rather than left in the undyed, or as-formed state. They possess excellent absorption characteristics, since they are minutely porous and can be given virtually any shade in the color spectrum.

Perhaps the most widely accepted method of oxide coating aluminum is that in which the film is produced electrolytically. In this "anodizing" process, aluminum is oxidized in either sulfuric, chromic, oxalic, phosphoric, sulfanic, or boric acid to produce a thin, inert, and reasonably durable film of aluminum oxide on the surface of the metal. These films will vary in thickness from 0.00002 to 0.0001 in., and appear in various shades of yellow, brown, gray or

Table V—Typical Methods of Coloring Magnesium and Magnesium Alloys

Color Obtained	Trade Name of Process	Manufacturer	Type of Process	Treatment Required Prior to Coloring	Coloring Procedure	Treatment Required After Coloring	Advantages of Coloring Process	Limitations of Coloring Process	Applications
Black	Dow No. 4	Dow Chemical Co., Midland, Mich.	Dip	Clean work thoroughly by vapor degreasing, by alkaline cleaning, or both.	Immerse work in solution of potassium chrome-alum, sodium dichromate, and water at 212 F for 2-15 min.	Remove work, rinse and dry.	Glossy black decorative finish obtainable.	Not suitable alone for prolonged outdoor exposure.	Fittings, brackets, aircraft parts, tools, etc.
Glossy black	Chrome-manganese bath	—	Dip	Surfaces must be clean and free from foreign matter.	Immerse work in a cold solution of sodium dichromate, magnesium sulfate, manganese sulfate and water for 1 hr.	Remove work, rinse and dry.	Good protection against corrosion; no dimensional change.	Bath may require aging under certain conditions.	Jewelry, toys, fixtures, etc.
Dark gray to black	Dow No. 8 (Modification of No. 3)	Dow Chemical Co., Midland, Mich.	Dip	Thorough alkaline cleaning required.	Immerse work in hydrofluoric acid bath at room temp. Wash thoroughly. Immerse in boiling solution of ammonium sulfate, sodium dichromate, ammonium dichromate, ammonia and water. Wash thoroughly. Immerse in a boiling solution of arsenious oxide.	Remove work, rinse and dry.	A hard, abrasion resistant film. No appreciable dimensional change.	Involved and complex treatment required.	Hardware, decorative trim, etc.
	AMC treatment "H"	Am. Magnesium Corp., Pittsburgh, Pa.							
Dark gray to black	Dow No. 2	Dow Chemical Co., Midland, Mich.	Dip	Clean work thoroughly by vapor degreasing or by alkaline cleaning.	Immerse work in a boiling or close to boiling solution of sodium dichromate, sodium dihydrogen phosphate, and water for 15-20 min.	Remove work, rinse and dry.	Good protection against corrosion; no dimensional change.	In alloys, color will darken toward black with increasing aluminum content.	Fittings, brackets, aircraft parts, tools, etc.
Dark brown to black	Dow No. 7	Dow Chemical Co., Midland, Mich.	Dip	Thorough alkaline cleaning required.	Immerse work in a hydrofluoric acid and water solution at room temperature; rinse in cold water; boil for at least 45 min. in a sodium dichromate and water solution.	Remove work, rinse and dry.	Provides best water resistance of all chemical treatments for magnesium. No dimensional change.	—	Hardware, decorative trim, etc.
	AMC treatment "G"	Am. Magnesium Corp., Pittsburgh, Pa.							
Bronze to dark chocolate brown	Acetic acid bath	—	Dip	Surfaces must be clean and free from foreign matter.	Immerse part in solution of sodium dichromate, magnesium sulfate, magnesium acetate, and acetic acid and water for 2-3 min. at room temp.	Wash or rinse thoroughly and dry.	Good corrosion resistance; low acidity; particularly suitable where only little dimensional change can be tolerated.	—	Hardware, decorative trim, etc.
Straw yellow to black	Dow No. 3	Dow Chemical Co., Midland, Mich.	Dip	Clean work by soaking for 15 min. in a boiling solution of 2-5% caustic soda.	Immerse part in boiling solution of ammonium sulfate, sodium dichromate, ammonium dichromate, ammonia and water for 30 min.	Wash parts off thoroughly in warm water.	Good where max. protection against corrosion is required. Film color darkens with increased aluminum content in Mg alloy.	Close control necessary when used on Mg-Mn alloys.	Fittings, brackets, aircraft parts, tools, etc.

Originally violet to black. Can be dyed to other colors.	Chromic acid bath	—	Electrolytic	Clean parts thoroughly before treatment.	Make work the anode in a 12% chromic acid solution for 5 v. a.c. (5% solution with 7 v. a.c. can also be used).	Remove work from tank, rinse and dry.	Good corrosion protection; can be subsequently dyed.	Extra equipment required over simple immersion tank.	Fittings, brackets, aircraft parts, tools, etc.
Brassy film on Dowmetal M; brown or black on other alloys.	Dow No. 11	Dow Chemical Co., Midland, Mich.	Dip	Thoroughly clean parts (Pickle if necessary).	Immerse work in magnesium sulfate, sodium dichromate and water solution for 30-60 min. at room temp. For production use 10-20 min. at 65-70 C.	Remove work, rinse and dry.	Protective coating has low electrical resistance.	—	Jewelry, toys, fixtures, etc.
Bronze or dark brown	Essex Aero C and M bath	Essex Aero Co., England	Dip	Clean surfaces by immersing in nitric acid or hot caustic compound.	Immerse part in solution of sodium nitrate, sodium dichromate, nitric acid and water for either 15-25 sec. in cold bath or 5-15 min. in bath at 90-100 C.	Wash off thoroughly in clear water.	Good corrosion resistance and little or no dimensional change.	Bath requires aging before use. Scrap magnesium added for aging purposes before use.	Jewelry, toys, fixtures, etc.
Yellow to bronze	Dow No. 10	Dow Chemical Co., Midland, Mich.	Electrolytic	Same as for chromic acid bath.	First treatment as in chromic acid bath then boil in a solution of sodium dichromate in water.	Remove work from tank, rinse and dry.	Increases corrosion resistance over that resulting from chromic acid bath. Especially suited for welded sheets and parts.	Extra equipment required over simple immersion tank.	Hardware, decorative trim, etc.
	AMC treatment "L"	Am. Magnesium Corp., Pittsburgh, Pa.							
Light gray or bronze	Dow No. 6	Dow Chemical Co., Midland, Mich.	Autoclave	Clean parts thoroughly and pickle.	Place work in solution of caustic soda and water and in autoclave 3-5 min. at 200 C and 225 psi. pressure.	Remove work, rinse and dry.	Highly corrosion-resistant film formed. Can be subsequently dyed.	Special equipment needed.	Jewelry, toys, fixtures, etc.
Neutral-colored film	Dow No. 12	Dow Chemical Co., Midland, Mich.	Electrolytic	Clean parts thoroughly and degrease.	Place work in a solution of lithium hydroxide, diethylene glycol, and water, 15-30 min. at a current density of 10-20 amp. per sq. ft. at 70-90 C.	Remove work, wash and dry.	Highly corrosion-resistant film. Can be subsequently dyed. Good abrasion resistance.	Only neutral-colored film formed. Must be dyed for decorative uses.	Decorative uses, toys, games, etc.
	AMC treatment "R"	Am. Magnesium Corp., Pittsburgh, Pa.							

white, depending upon the alloy being processed and length of processing time. The formation of these anodic films results when the aluminum is made the anode in an electrolytic bath instead of the cathode, as in electroplating processes. An initial oxide film is formed on the aluminum surface, and progressive oxidation takes place beneath the film thus formed. Thus, as oxidation continues, the most recently formed film is always nearest the metal and the oldest part of the film is on the surface. This outer portion of the film is less dense and is considerably softer than that part of the film adjoining the metal itself since it has been subjected to the most severe solvent action which tends to dissolve some of the oxide film formed. This is, of course, advantageous from a dye absorption standpoint and contributes much to the ease with which the oxide film can be subsequently colored.

In the electrolytic processing methods, electrolytes capable of yielding oxygen on electrolysis are used, and several proprietary anodizing processes involving the use of these electrolytes are available. The acids that are commonly used in anodizing processes vary in their effect and possess marked differences in processing time required, advantages, etc.

The anodizing method of producing an oxide coating on aluminum has the definite disadvantage, however, of requiring electric current of low voltage and the attendant equipment involved. This oftentimes entails considerable set-up expense and results in higher costs than would otherwise be the case. In addition, certain of the oxide films that are formed are not readily dyed and difficulty is often encountered in obtaining a suitably satisfactory coating.

To offset some of these disadvantages, chemical treatments have been developed for producing oxide coatings on aluminum surfaces without recourse to anodizing. These chemically-produced coatings are fairly thin, being in the order of 0.00005 to 0.0001 in. thick and are of exceptional value when small parts such as nuts, bolts, rivets, etc., cannot be racked easily for anodizing purposes.

Chief advantage of the chemically-produced oxide coatings lies in the fact that they are largely free from the perforations which are frequently experienced on thin aluminum surfaces after anodizing. They afford particularly good corrosion resistance to aluminum alloys that contain no copper, such as 2S, 3S and 52S, but they are not exceptionally resistant to abrasion. Although the oxide coatings formed on aluminum by electrolytic and chemical means often appear in color as they form, a much greater variety of color tones usually can be achieved through subsequent dyeing operations. The dyes that are commonly used for this purpose penetrate the oxide coating and result in deep colors which have an attractive underlying metallic sheen. Oftentimes, contrasting two-tone effects can be achieved for added beauty. As a general rule, however, these dyed colors are suitable only for interior service, as they will eventually fade on continued exposure to sunlight and weather.

Where more severe service conditions are to be met, mineral pigments are used to color oxide coatings. These colors, while neither producing the translucent effect nor having the brilliance and range of color of dyes, possess a much greater resistance to fading when exposed to light.

Several typical methods of coloring aluminum and aluminum alloys are listed in Table IV.

Magnesium

The comparatively rapid rise of magnesium and its alloys in recent years for various architectural, structural and decorative applications has led to the development of several methods of treating the metal in order to obtain better resistance to corrosive atmospheres. In the past, inadequate corrosion resistance was perhaps the largest single factor limiting the continued expansion of magnesium applications. Some of the alloys developed during recent years have much better chemical stability than their predecessors, but even now, the successful use of magnesium and its alloys for many important applications depends on the presence of suitable protective coatings.

To meet this problem, several coatings applied by chemical and electrolytic means have been developed. These coatings, as formed, range in color from a pale straw yellow to a deep black and include various shades of brown and gray. Since, by formation, these colored coatings protect as well as beautify, they are often used alone to enhance the appearance of a product without the necessity for the subsequent painting, enameling or other finishing technique that would otherwise have to be applied.

If colors other than those of the coatings themselves are desired, dyes can sometimes be used in much the same manner as in the case of the aluminum alloys. With magnesium, however, the biggest drawback is the fact that the oxide films are not self-healing and their characteristics are in no way comparable to those of the anodic films developed on aluminum and its alloys. The oxide films on magnesium can be damaged fairly easily, particularly on corners or projections exposed to greater than normal abuse, and for this reason care must be utilized in their application.

In general, as far as subsequent dyeing operations are concerned, considerable progress must still be made before a completely satisfactory dyeing procedure for magnesium is developed. The present dyeing techniques leave much to be desired, particularly in regard to color tone, depth, and over-all translucency. Since most of the colored surface films on magnesium and its alloys are comparatively soft, they are not suitable for service conditions involving wear and abrasion. The coatings vary in regard to the loss of magnesium resulting from the treatment, but most of them will not cause any important dimensional changes in the magnesium parts. For the most part, the coatings are developed with reasonably uniform appearance. However, when applied in assemblies composed of different alloys of magnesium, a variation in protective value and uniformity of appearance is likely to develop.

Some typical methods of coloring magnesium and magnesium alloys are listed in Table V.

Final Finishing

As mentioned earlier, most of the colored films that can be applied to various metals by chemical and electrolytic means are somewhat limited in their resistance to corrosion and abrasion. This weakness, however, can be overcome to a certain degree by a supplemental application of wax, oil or lacquer after the coloring has been achieved. In addition, these subsequent treatments enhance both the color and appearance of the processed work. The oil or wax dips generally utilize either linseed and tung oils or lanolin and paraffin in their makeup. For certain parts, such as nuts or bolts, the subsequent application of wax or oil acts as a permanent lubricant and adds materially to the ease with which the threaded portions can be joined.

The lacquer protection is best suited for non-friction service such as architectural trim, decorative applications, jewelry, etc., where frequent reapplication of final finish is both difficult and expensive. The lacquer coating will withstand considerably more exposure than either the wax or oil finish and, at the same time, will result in a greater variety of final finishes available, ranging from a high gloss to a dull matte appearance, depending on the drying characteristics of the particular lacquer used.

The relatively high absorption characteristics of the oxide coatings that are dyed to the desired color require the use of a sealing process after the color has been applied. This is necessary, because without this subsequent sealing, stains or smudges would mar the appearance of the finished piece.

Sealing can best be achieved by dipping the piece in boiling water. This has a tendency to change the form of the oxide and actually increases its volume, and the resultant swelling action closes the pores against further absorption. The original dyed color and appearance of the oxide film is unchanged by this treatment. Other similar sealing or setting treatments involving hot solutions of nickel or cobalt acetate are used for finishes colored by dyes. Following sealing operations, wax, oil or lacquer should be applied for increased protection against corrosion.

All chemical and electrolytic coatings are usually buffed as part of the final finishing treatments. Standard cotton or flannel buffs are used, together with fine buffing compound. This assures a surface free from microscopic irregularities and imperfections, and is particularly used for objects subject to extremely close scrutiny, such as jewelry, decorative items, etc.

HEINZ
57
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Acknowledgment

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Enthone, Inc., New Haven, Conn.
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Hanson-Van Winkle-Munning Co., Matawan, N. J.
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Materials & Methods

Materials Engineering File Facts

NUMBER 176

June, 1949

MATERIALS: Aluminum

75S Aluminum Alloy

75S is intended to replace 14S, 17S and 24S in applications where its higher strength to weight ratio will affect an appreciable saving in weight. It can be substituted for 24S material without any difficulty, provided the parts require little or no forming. Thus, parts such as doubler plates, web sheets, gussets and simple angles, can be made from 75S without any affect on production, but with an increase in strength.

75S has good machining qualities in its annealed state, comparable to 24S. Its corrosion resistance is good and improves with heat treatment and artificial aging. Due to its high yield strength, low elongation, greater spring back and poor shrink qualities, heat treated and aged 75S cannot be formed by production tools developed for 24ST aluminum alloy.

Available Forms

Bar, rod, plate, wire, extruded shapes, and forgings.

Chemical Composition—% Analysis

Element	75ST Bare	75ST Clad	
		Core	Cladding
Zinc	5.1-6.1	5.1-6.1	0.75-1.25
Magnesium	2.1-2.9	2.1-2.9	0.10
Copper	1.2-2.0	1.2-2.0	0.10 max.
Chromium	0.15-0.40	0.15-0.40	—
Manganese	0.10-0.30	0.10-0.30	0.10 max.
Iron	0.7 max.	0.7 max.	—
Silicon	0.5 max.	0.5 max.	0.7
Titanium	0.2 max.	0.2 max.	—
Others, Each	0.05	0.05	0.05
Others, Total	0.15	0.15	0.15
Aluminum	Remainder	Remainder	Remainder

Corrosion Resistance

75S attains its maximum resistance to corrosion when heat treated and fully aged. This alloy has corrosion resistance qualities comparable to 24S and should receive the same protective finishing process. Clad 75S suffers less stress corrosion than clad 24S under identical conditions, and there is less loss in mechanical properties in the bare 75S than in the bare 24S. Unclad 75S cannot be spot welded due to severe loss in corrosion resistance; however, spot welded clad 75S resists corrosion satisfactorily. Dissimilar metal contacts should be eliminated to avoid galvanic corrosion.

Mechanical Properties

75S CLAD — MINIMUM VALUES EXCEPT AS NOTED

Condition or Temper	Thickness, In.	Tensile Strength, Psi.	Yield Strength at 0.25% Off Set or at Tension Indicated		Elongation in 2 In. %
			Psi.	Extension Under Load In. in 2 In.	
A (Annealed)	Up to 0.500	36,000	—	—	10
T (Heat Treated and Aged)	Up to 0.039	70,000	60,000	0.016	7
	0.040-0.499	72,000	62,000	0.0164	8
	0.50-1.00	77,000	66,000	0.0168	6
	1.001-2.000	77,000	66,000	0.0168	4

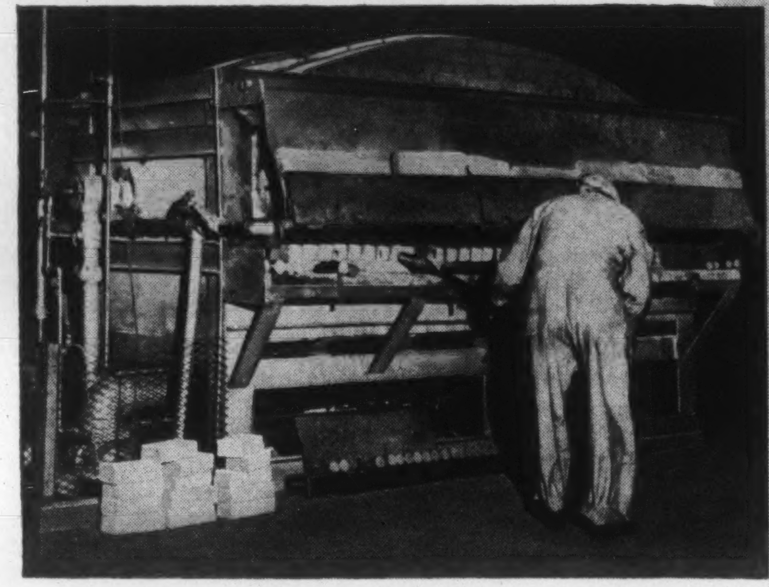
75S BARE — MINIMUM VALUES EXCEPT AS NOTED

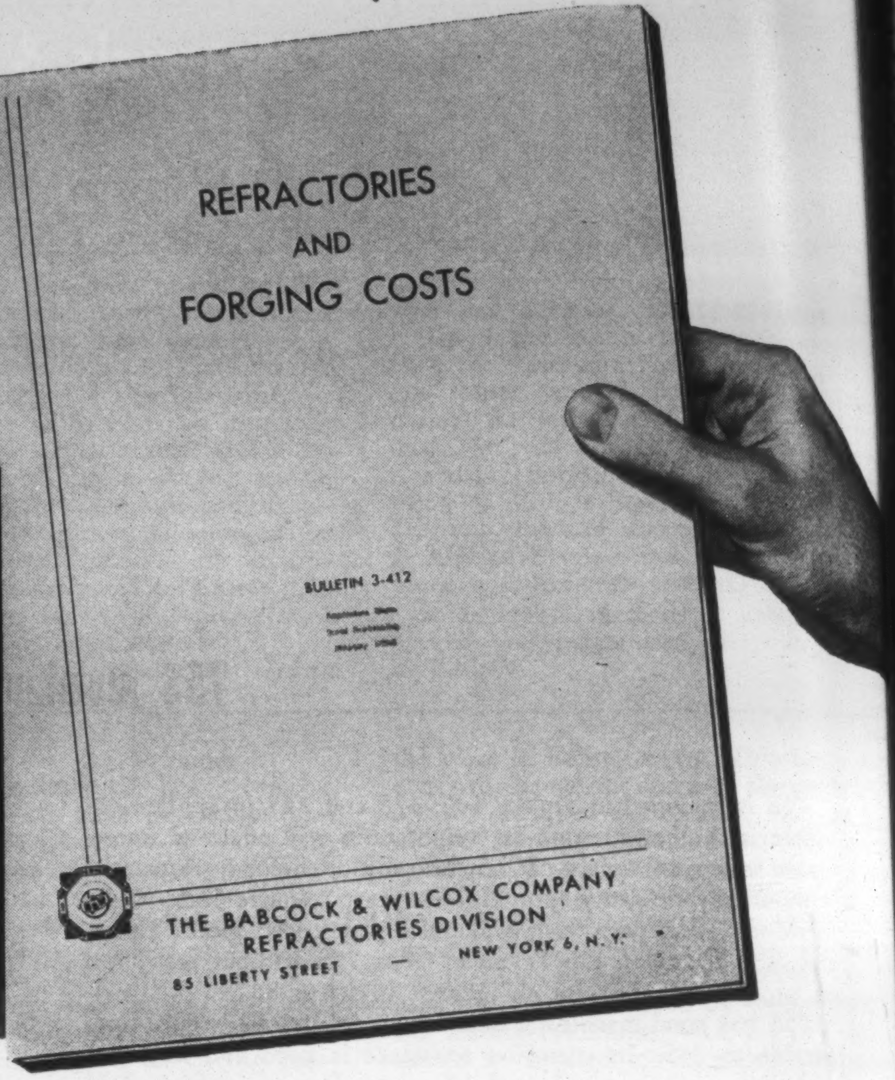
Condition or Temper	Thickness, In.	Tensile Strength, Psi.	Yield Strength Psi.	Extension Under Load In. in 2 In.	Elongation in 2 In. %
A (Annealed)	0.012-0.500	40,000 max.	—	—	10
T (Heat Treated and Aged)	0.016-0.039	76,000	65,000	0.0166	7
	0.040-0.050	77,000	66,000	0.0168	8
	0.501-1.000	77,000	66,000	0.0168	6
	1.001-2.000	77,000	66,000	0.0168	4

EXTRUSIONS — MINIMUM VALUES EXCEPT AS NOTED

	Yield Strength, Psi.	Ultimate Strength, Psi.	Elongation % in 2 In. Round Spec. 0.5 In. Dia.
75ST	70,000	78,000	6
75SO	40,000 max.	—	6

(Continued on page 85)





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Materials & Methods

Materials Engineering File Facts

NUMBER 176 (Continued)

75S ALUMINUM ALLOY

Physical Properties

Properties	Condition A Bare	Condition A Clad	Condition T Bare	Condition T Clad
Shearing Strength, Psi.	—	—	47,000	—
Hardness (Rockwell)	H86-H96	H86-H96	B85-B95	B80-B90
Modulus of Electricity	10,400,000 Psi.			
Modulus of Rigidity	3,850,000 Psi. (approx.)			
Poissons Ratio	0.33 (approx.)			
Specific Gravity	2.80			
Weight Lb./Cu. In.	0.101			
Thermal Conductivity 100 C C.G.S. Units	0.28			
Average Coefficient of Thermal Expansion				
68-212 F	0.0000129			
68-392 F	0.0000135			
68-572 F	0.0000144			
Electrical Conductivity in Percent—International Annealed Copper Standard	30			

Processing and Fabrication

75S is best formed in its W (freshly quenched) condition and is comparable to 24SW. Although it strain hardens more rapidly than 24SW, it age hardens much more slowly at room temperature. There is little or no warpage in age hardening 75S after it is formed in its W state. There are two drawbacks in forming 75S in its O (annealed) condition. Due to the elaborate annealing and stabilizing treatment required, severe forming would be impractical. Also, formed parts would require reworking after heat treatment due to the distortion resulting from the necessarily rapid water quenching. Forming in the T condition is the most desirable from the production standpoint. However, unless forming is done at temperatures ranging from 250 to 450 F, 75ST cannot be adapted to rubber forming or stretching.

Heating time must not be any longer than 15 to 20 min. at 400 F in order to avoid appreciable loss in strength of the alloy. A decrease of not more than 5% in tensile strength can be expected if the heating is kept within the following limits:

250 hr. at 275 F
15 hr. at 325 F
30 min. to 1 hr. at 375 F
15 to 20 min. at 400 F
40 hr. at 300 F
5 hr. at 350 F

75S can only be spot welded in its clad sheet form. Bare 75S sheet and extrusions cannot be adapted to resistance welding processes. Like 24S, 75S cannot be fusion welded. However, it can be spot welded.

Thermal Treatment

	Metal Temperature, F	Approx. Time of Heating (Hr.)	Temper Designation	Remarks
Annealing	775	2 - 3	75S-O	Should be followed by heat for 6 hr. at about 450 F if material is to be stored for extended time.
Solution Heat Treatment	870	—	75S-W	Sheet can also be heat treated at higher temperature (up to 25 F) if desired.
Precipitation Heat Treatment	250	22 - 26	75S-T6	A two-stage treatment comprising 4 to 6 hr. at 210 F followed by 8 to 10 hr. at 315 F can be used for sheet, but anyone using it may wish to consult his patent counsel regarding U.S. Patent #1,858,092.

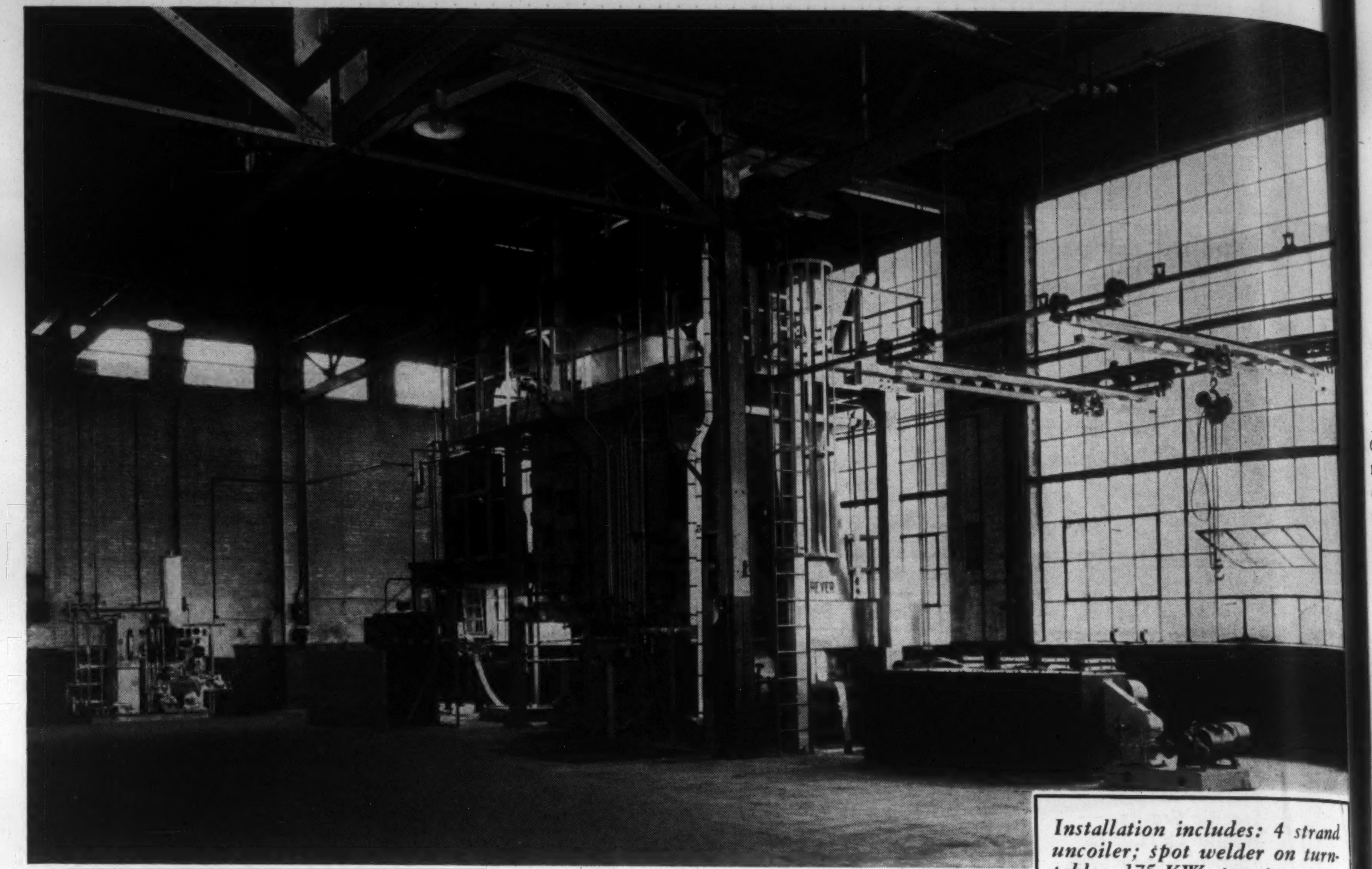
Minimum Recommended Bend Radii

(For 90-deg. Cold Bends)

Condition	Gage up to 0.065	Gage 0.065 to 0.129	Gage 0.129 to 0.250
75SO Aluminum Alloy	0	0	0 - 1t
75ST Aluminum Alloy	1½t - 5t	3t - 6t	4t - 7t
t = thickness of sheet in inches			

Very adaptable to structures requiring high strength (better than standard structural steel) with weight at a premium. Used extensively in large airplanes. Good in mobile equipment, especially when exposed to various atmospheres, high pressure hydraulic units and piping systems. Sheet can be spot welded in clad form, but cannot be fusion welded in any form.

Prepared by C. C. Hurlburt



Installation includes: 4 strand uncoiler; spot welder on turntable; 175-KW two-pass vertical furnace; two-pass vertical cooling tower; multi-chamber pickling tank; drying unit; master pinch roll; 4-head recoiler; complete hi-nitrogen atmosphere equipment.

DREVER CONTINUOUS VERTICAL STRIP ANNEALING LINE

WATERBURY ROLLING MILLS, INC., WATERBURY, CONN.

Clean, bright or matte finish brass or nickel-silver strip is being annealed continuously in this installation which handles an average production of 2000#/hour of two 12″ strands or four 6″ strands .030″ thick. Max. strand width 13″; min. width 2″; max. thickness .060″; min. thickness .008″.

Non-explosive reducing atmosphere contains low percentages of CO and H— with practically no traces of CO_2 and moisture.

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We will be pleased to furnish data obtained from this and other continuous strip lines for comparison with your present annealing practice.

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MATERIALS & METHODS

DIGEST

A selective condensation of articles—presenting new developments and ideas in materials and their processing—from foreign journals and domestic publications of specialized circulation.

Edited by H. R. CLAUSER

Plating and Pickling Beryllium-Copper Components

The use of beryllium copper is firmly established in all types of precision instruments because of its suitability for springs, diaphragms and parts that have to withstand corrosion, erosion or wear. In spite of its normally good corrosion resistance, electroplated finishes may be required in some cases. Details on plating and pickling procedures are given by E. E. Halls in the Feb. 1949 issue of *Metallurgia* (British).

For preserving a "white" finish under moderately corrosive conditions, nickel plating has in the past been regarded as most suitable, but more recently it has been extensively supplanted by tin. The tin plate retains a white finish better, provides an excellent base for soft soldering, and is useful where bimetallic junctions are involved. For high frequency conductance and low contact resistance, silver plate is normally necessary. Where a good wearing surface is also required, the silver is overplated with rhodium.

For electrical contact reasons, particularly for very low resistance at very light pressures, gold plating is used, either as a direct plate or a copper, silver or nickel underlay with a gold top coat. For levelling differences of potential at bimetallic junctions, zinc or cadmium are sometimes sought, but their use is not recommended unless essential They tend to diffuse into the base metal and to corrode rapidly under humid conditions.

Pickling is required before plating and after heat treatment. In the latter case, acid pickling is sufficient unless the work is contaminated with oil and grease. A 10% sulfuric acid solution is advocated, with elevated temperature if convenient. To provide uniformity of appearance, this acid pickle should be followed by an oxidizing pickle. The best solution is 5% sulfuric acid with 2 to 3% potassium or sodium dichromate at room temperature. Plating directly after this treatment is unsatisfactory because of poor adherence.

For plating, complete descaling in the acid pickle should be followed by two quick dips in nitric-sulfuric acid solutions (the first, two parts by volume of concentrated nitric to one of concentrated sulfuric acid, and the second one to three, both at room temperature). If the plating is to be done in an alkaline electrolyte, the work should be rinsed in a sodium cyanide solution and in water.

Powder Metallurgy Developments

The big problem in powder metallurgy is still where and how it can be best used for structural parts. As indicated by the digests given here, a majority of the papers presented at the recent annual meeting of the *Metal Powdr Assn.* in Chicago (Apr. 5-6) were concerned with this problem in one way or another.

How to Sell Metal Powder Parts

Two of the papers in particular stressed the need of clearly defining the capabilities as well as limitations of metal powder parts. M. Boorky, the Presmet Corp., gave some worthwhile thoughts on the obstacles that must be overcome to achieve a greater use of metal powder parts. In his paper, "Selling Parts Made from Metal Powders," he pointed out that one of the biggest jobs is to educate all parties concerned, including the salesmen of parts producers, engineers, executives and even purchasing agents, in the fundamentals of powder metal fabrication.

In general, for best results the parts must be specifically designed for powder metal fabrication; therefore, the engineer must be educated as to the whys and wherefores of powder metal designs. Unfortunately, uniform and satisfactory specifications have not as yet been developed for the field of structural parts. Thus, regular tensile and hardness tests do not indicate some of the unique qualities, such as controlled porosity, which are often valuable. There is also a lack of standard inspection procedures; such tests as putting the part in a vise and striking it with a hammer, or subjecting the material to Rockwell or Brinell hardness tests, are often misleading.

A Look at Tolerances

W. R. Toeplitz, Bound Brook Oil-Less Bearing Co., in his paper "Tolerances of Finished Metal Powder Parts," took a critical look at the close tolerances claimed for metal powder parts and then advocated a more realistic approach to this matter of dimensional tolerances. To demonstrate his point that the tolerances obtained on the actual parts frequently do not meet those on the drawings, he compared inspection results on many actual samples with the drawing tolerances. In most of the examples the drawings specified closer tolerances than those attained on the part.

From his investigation he has concluded that powder metallurgy parts vary greatly in dimensional accuracy, and that there is no direct relationship between the loss of dimensional accuracy and the intricacy of the part, nor between the loss of dimensional accuracy and the kind of material from which the part is made. Finally, he says that the extremely close control of a large number of variables is the basis for achieving close tolerances and producing satisfactory metal powder parts.

Powder Metallurgy Successfully Applied

For many engineers powder metallurgy has provided at least a partial answer to the twin problems of reducing costs and avoid-

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DIGEST

ing material scarcities, according to J. L. Bonanno, the Lionel Corp. In his paper, "Powder Metallurgy from the Design Engineer's Viewpoint," he described his company's extensive use of metal powder parts. A number of actual examples were presented where the characteristics of metal powder parts have contributed to cost reduction and improved performance.

The advantages gained by use of powder metallurgy included: (1) Replacement of zinc die casting alloy by cheaper powdered iron. (2) Greater availability of metal powders as compared to other forms. (3) Reduced raw material inventories resulting from stocking only four or five powders as compared to the assortments of widths, gages, tempers and compositions of metals in sheet, rod and other special forms. (4) Dimensional stability of sintered powder parts under conditions of high heat and humidity as against the tendency of zinc castings to disintegrate, warp and change dimensions over a period of time. (5) Controllable coefficient of friction ranging from bearing to friction surfaces. (6) Controllable porosity for producing special oil-retaining parts. (7) Readily obtainable homogeneity of compacts free from voids and gas pockets common in cast parts. (8) Elimination of trimming cost, which in die cast parts often exceeds the cost of the casting itself. Also, the elimination of scrap which in small machined and stamped parts may exceed the weight of the finished article.

Metal Powders in Magnetic Fluid Devices

In recent years magnetic fluids have found application in an increasing number of devices such as clutches, dash pots, hydraulic valves, shock absorbers, and the like. H. D. Saunderson, National Bureau of Standards, in his paper, "Characteristics of the Materials Involved in the Magnetic Fluid Clutch," discussed the part played by metal powders in this development.

The magnetic fluid consists of a magnetic powder material dispersed in a vehicle of oil to which an additive is added to improve the physical characteristics of the fluid. One of the characteristics which govern the type of powder to be used is permeability. Pure iron powders exhibit the highest permeability. While hydrogen-reduced iron has very high permeability, other difficulties, such as its extreme instability, make it unsuitable. The carbonyl irons have been the most universally successful.

The problem of wear also influences the selection of the metal powder. It is desirable that the particle hardness be somewhat lower than the surface hardness of dead-soft annealed SAE 1010 steel.

An interesting possible application for

magnetic fluids is as a molding material. Experiments have been conducted in which a pot of the fluid is surrounded by a coil and the part to be molded is pressed into the fluid and the coil is energized, thus solidifying the mixture. The material to be molded, which can be any low melting point material, is then poured into the mold. After the part has hardened, the magnet is de-energized and the mold again becomes liquid, permitting easy withdrawal of complex molded parts.

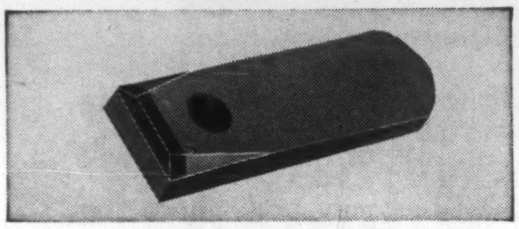
Selenium Coatings for Protecting Magnesium Alloys

It has been known for many years that thin coatings of selenium, produced by immersion in selenious acid, have considerable value for protecting magnesium-base alloys against corrosion. There has been no large scale use of selenium coatings, however, because they reduce the fatigue strength markedly due to the surface attack on the magnesium and their adhesion is poor on magnesium-manganese binary alloys. L. Whitby, in the Mar. 1949 issue of *Metallurgia* (British), presents the results of experiments that show how these disadvantages may be overcome by the addition of sodium dichromate to the selenium dioxide bath.

A recommended bath consists of an aqueous solution of 7.5% sodium dichromate and 3% selenium dioxide, used at its boiling point. The optimum immersion time depends on the type of magnesium alloy being treated. For 1.6% manganese alloy, the time is 5 min., followed by mechanical removal of the thin, loosely adherent surface layer if the coating is to be used as a base for paint; 30 min. is required for a 5.8% aluminum alloy. The operational life of the solution is exceptionally long.

There seems to be no advantage to anodic treatment as compared with simple immersion in the bath without current. The composition of the coatings consists largely of selenium, but some chromium is also present and may account for the marked difference in properties of these coatings and the simple selenium coatings.

With the 5.8% aluminum alloy, the selenium-dichromate immersion treatment produces coatings that are more resistant to salt spray attack and more effective as bases for paint than either selenium or



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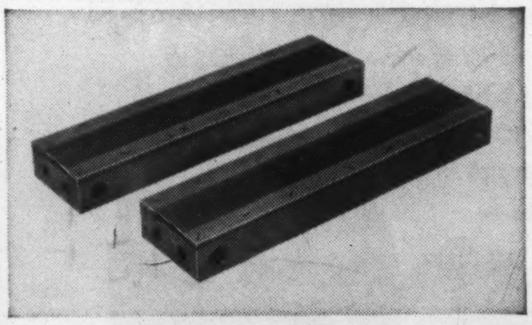

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DIGEST

chromate coatings. With the 1.6% manganese alloy, little protection seems to be gained by the selenium-dichromate treatment, but this may be a result of a high error level in testing. Fatigue data on a 4.2% aluminum alloy indicate that the straight selenium treatment reduces the endurance limit about 21% as compared to the untreated metal, but the selenium-dichromate treatment is considerably less harmful in this respect.

New Rapid Hardenability Test

The Jominy hardenability test requires too much work, according to H. Krainer, F. Swoboda and F. Rapatz in the Feb. 17, 1949 issue of *Stahl und Eisen* (German). They agree, however, that mass production heat treatment requires hardenability control. A quick test of the tendency of austenite to transform to pearlite or bainite has been found more satisfactory than the Jominy test for their purposes.

Small plates (about 0.8 by 2 by 0.08 in.), which may be cast, are used. These samples are quenched into a lead bath at the temperature of the most rapid transformation, held for a predetermined time, quenched to room temperature and examined for hardness and, in some cases, microstructure. The preliminary work, which should be carried out on several heats of the same grade, involves the determination of the temperature of most rapid transformation (the pearlite or bainite nose) and the holding time at this temperature that gives the greatest differentiation among the heats. For example, with a 0.35 carbon, 1.6 chromium, 0.1% vanadium steel, the pearlite nose was found to be 1220 F and the best time 2 min.

The correlation between the results of these control tests and specification requirements as to attainable hardness in larger sections is adequate. Only heats that give borderline results in the hardenability test have to be tested further. With sufficient experience, it is possible to estimate with some degree of accuracy the maximum size of a heat that will harden through. The test has also proved practical as a laboratory tool to investigate the effect of composition on hardenability.

One disadvantage of the test is the indirect nature of the relationship between the results and practical heat treatment. Moreover, the test is not suitable for shallow hardening steels because the holding time should be at least 20 sec. Although this

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test is not the best for all kinds of steel, it has been successfully used in a number of instances and offers certain advantages (notably speed) over the Jominy test.

New Technique for Welding Chromium Pipe

Development of a new procedure for welding 4 to 6% chromium pipe was disclosed recently by M. Van Blaircom of Houston Pipe & Steel, Inc. In the new process a large preheating tip with oxy-acetylene was used first to bring the temperature of the joint up to 600 to 800 F and keep it there while the welding was done using G-E chrome electrode Type W-1502 (ASTM-AWS Spec. No. E-502). After this the temperature was raised to 1200 to 1350 F and the joint was wrapped with asbestos tape to a minimum thickness of 1 in. and cooled to room temperature.

This technique did not make the weld metal so hard that it became brittle. Test figures showed an ultimate tensile strength of 73,200 psi., and a satisfactory rating on a 180-deg. root bend. Brinell hardness in the weld was indicated as 248, while Brinell hardness in the pipe was 174. A Charpy impact notched test made in the weld metal at 70 F gave a value of 49.0 ft.-lb.

Where greater ductility and elongation was required, a furnace anneal at 1600 F was given after the pipe had cooled. This resulted in an average elongation of 40% in 2 in.

Briefs

What Does Testing Mean? The relative value of five different methods of testing castings to evaluate their serviceability was recently discussed by F. G. Sefing, International Nickel Co., Inc., in a talk before the *Pittsburgh Foundrymen's Assn.* He particularly emphasized the specifications and testing which properly evaluate the serviceability of the castings. This last point, according to Mr. Sefing, is one which involves the engineer's analysis of the properties most desired in a casting and the properties usually measured in a test bar.

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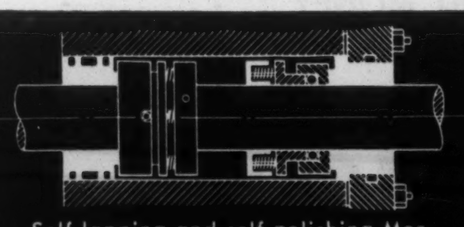

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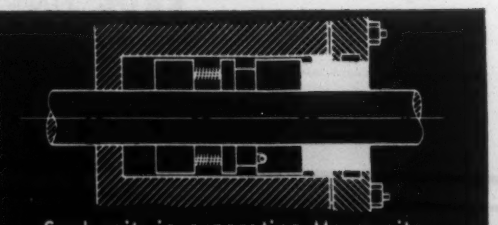

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DIGEST

In this connection, he appealed to the foundrymen to assist the engineer in setting up proper and adequate specifications.

●

Good Quality Control Saves Money. In a recent talk before the *American Management Assn.* in New York, J. J. Manuel, Westinghouse Electric Corp., stated that adequate quality control and preventive inspection programs can save industry more than 3 billion dollars a year. This amount, he said, is now lost in substandard products that must be scrapped before they leave the production line. To prevent this loss, Mr. Manuel suggested a five-point program, including: (1) clearly defined standards of quality, (2) sufficient inspection coverage, (3) proper inspection methods, (4) correct inspection tools, and (5) maintenance of adequate records.

●

Galvanized Steel Being Studied. The tendency of the zinc coating or galvanizing on steel water pipe to dissolve varies with the substance in solution in the water, according to the study being conducted by the Committee on Steel Pipe Research of the *American Iron & Steel Institute.* The program was designed to determine the causes of exceptions to the usual long life of galvanized steel pipe in severely corrosive natural waters. Cases have been reported in which galvanized steel was pitted in hot water, where ordinarily no pitting of the steel results because of the electrolytic protection afforded by the zinc. In studying these exceptional cases it was discovered that bicarbonates and nitrates accelerate the reversal of the normal relationship, while chlorides and sulfates prevented the reversal. For a natural water, therefore, the probability of reversal of the normal behavior would depend on the relative quantities of these chemical substances in the water and to a less extent on the temperature of the water.

●

Cermals as Gas-Turbine-Blade Material. The results of the initial investigation of carbide-type cermals of 80% titanium carbide plus 20% cobalt are reported by C. A. Hoffman, G. M. Ault and J. J. Gangler in a paper issued by the *National Advisory Committee for Aeronautics.* Their results

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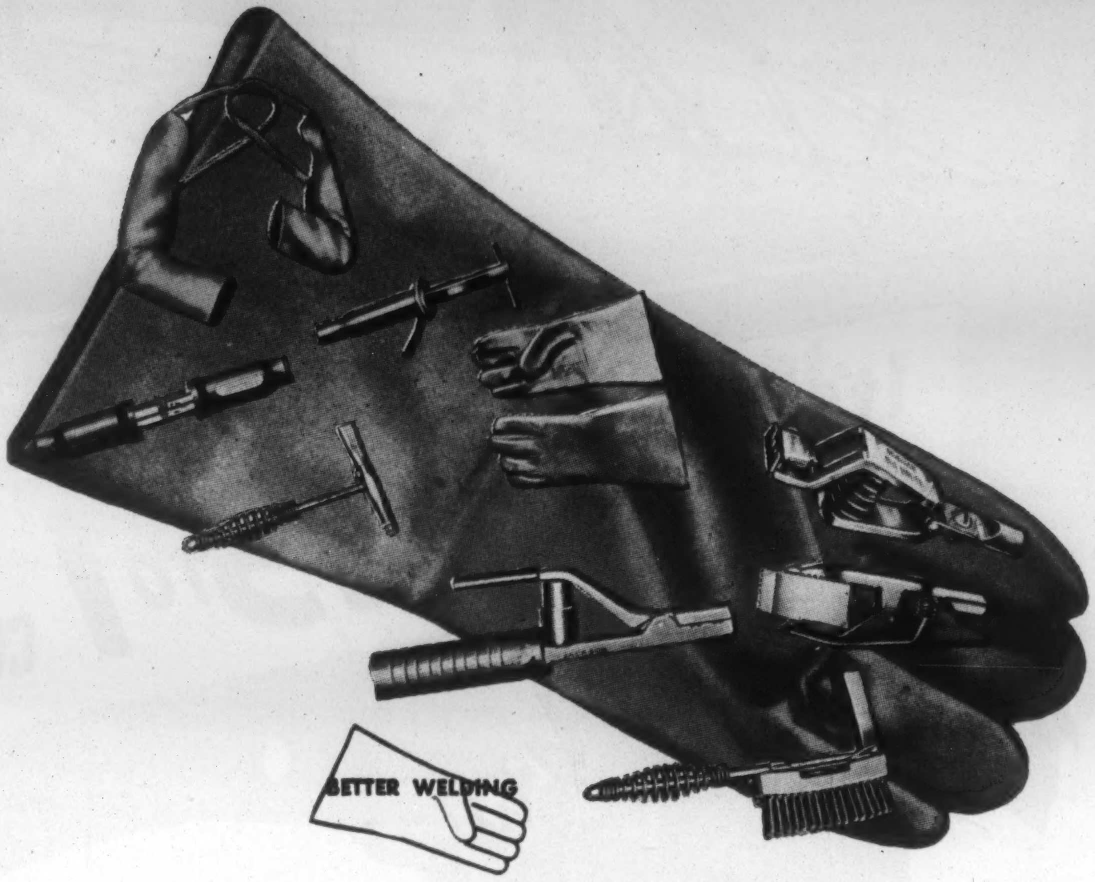
indicated that this carbide type cermal shows promise for gas-turbine-blade application at relatively high temperatures for short times. However, more care than with alloy blades must be exercised in handling them. They also found that this cermal has high thermal conductivity, which causes the turbine disk to run hotter than do metal blades.

Measurement of Magnetic Properties Indicates Formability of Steels

The magnetic directional properties of steels are a valuable indication of their formability as well as their suitability for electrical equipment. During the past 20 years several torque magnetometers have been built to measure these properties, but they have been designed chiefly for laboratory work. A new instrument, called the "recording torque magnetometer," has now been designed by D. S. Miller at the Research Laboratory, United States Steel Corp. of Delaware. It can plot a conclusive and accurate magnetic torque curve of any steel in a matter of 6 min., thus making magnetic torque testing automatic and practical for shop and mill use.

The principle of the instrument is quite simple. Two strong electro-magnetic coils are placed end to end with a short gap between them. The specimen disk, which is about 1 in. in dia., is mounted horizontally between the coils and rotated one-half revolution in 6 min. As the disk rotates the magnetic field affects the rotation of the sample, depending on magnetic directional properties in the specimen. Beneath the sample and attached to its mount is a strain gage which measures this effect at various points of rotation. The measurements are translated automatically by a moving pen from the gage to the chart paper of a recorder.

In almost all kinds of steel there are two positions in which the magnetic directional properties are most noticeable, one parallel to the direction of rolling and the other at right angles to this direction. If deep caps or rich curves are to be formed, as in bottle tops, fenders, washing machine tubs and cooking pots, steels with little magnetic directional properties are preferred. If the steel being tested is of a composition high in silicon and is to be used to make cores for transformers, a strong directional indication is preferred, but minimum directional properties in the same type of steel are desired for the construction of electric motors and generators.



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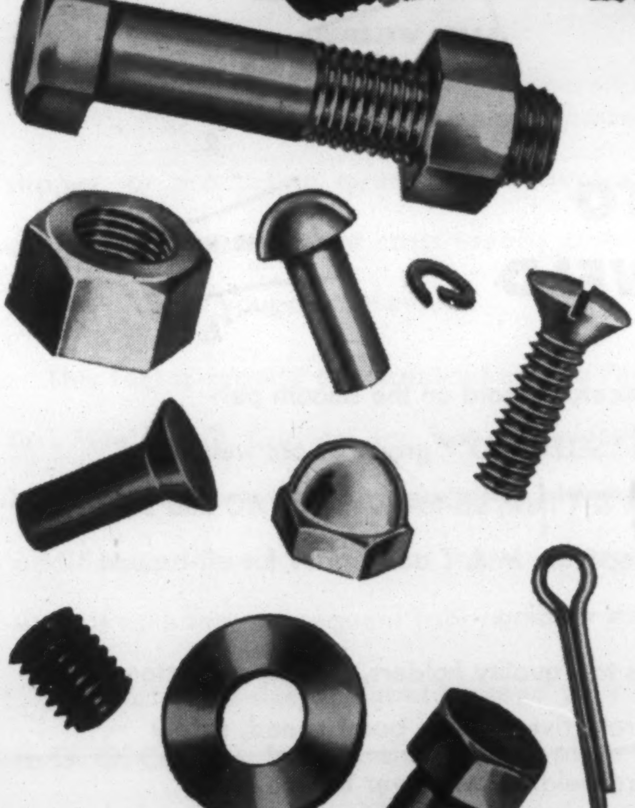

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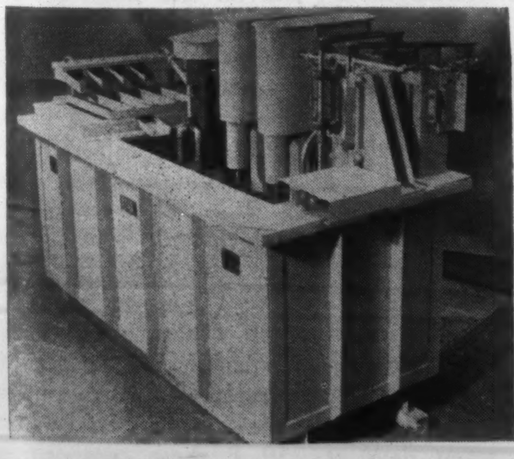
New Materials and Equipment

Salt Bath Furnace Meets Isothermal Heat Treating Requirements

A salt bath quenching furnace designed for the martempering and austempering heat treating processes has been developed by *Ajax Electric Co., Inc.*, Frankford Ave. at Delaware Ave., Philadelphia 23.

The furnace provides a vigorous, upward flow of molten salt in headers, into which the hot work is introduced. The salt is circulated by submerged pumps. A separate pump for each header concentrates a great volume of liquid salt into a confined quenching area. Thus, it becomes possible to obtain hardness equal to oil quenching together with the usual benefits of martempering and austempering, namely, greatly reduced distortion and the elimination of quench cracks.

The need of removing the chloride contamination is solved in a unique manner. A separate steel tank is built into one end of the unit. A motor-driven pump lifts the salt from the isothermal quench bath to a trough arranged above the separation tank. This trough is cooled constantly by a blast of air that chills the salt to the optimum separating temperature, which is always well below the operating temperature of the quench bath. The chloride contaminant is precipitated out of solution and collected in wire mesh filter baskets, while the purified nitrate salt—still molten—enters the separation chamber. From there it flows back into the isothermal quench bath, so that the whole cleaning process is on a continuous basis.



This new isothermal quench furnace assures rapid and uniform cooling and removal of chloride contamination.

New Aluminum Alloy Developed for General Purpose Use

Development of a new general purpose aluminum alloy, designated as 150S, has been announced by the *Aluminum Div., Permanente Products Co.*, 1924 Broadway, Oakland 12, Calif. Its combination of properties might be described as intermediate between the popular common alloys 3S and 52S.

Alloy 150S is expected to be of particular interest to the refrigeration, appliance, utensil and building materials manufacturers. During the testing period the alloy was also successfully used for the fabrication of such widely diversified products as vending machine parts, irrigation pipe, fruit lugs, wheelbarrow trays and store shelving.

The yield strength of the alloy is intermediate between 3S and 52S. Its workability is approximately equal to that of 3S and its finishing characteristics superior to 3S. Corrosion resistance is said to be superior to 3S, and welding and brazing characteristics of the alloy are termed intermediate between 3S and 52S.

Tempers available in 150S are: S0 for deep drawing; H22 for shallow drawing; H38 for blanking and slight forming; and H32, H34, H36.

According to the producer, the improvement in strength and finish of a product made of 150S as compared to the same article made of 2S or 3S is expected, in most instances, to outweigh the slight increase in material cost. In many cases the higher strength will permit a slight gage reduction and actual lowering of material costs.

- Gaskets, diaphragms, sleeves, packings, channel, and numerous other molded, extruded, punched, and die or lathecut rubber parts fabricated from the new X-6 Silicone rubber stocks, which have been developed specifically for extreme low temperature applications, are now available from the *Stalwart Rubber Co.*, 165 Northfield Rd., Bedford, Ohio. The brittle points of the low temperature X-6 Silicone stocks, measured on ⅛-in. thick sections according to ASTM D736-43T, range from –150 to –170 F. Rubber parts fabricated from these stocks are recommended for applications involving continuous temperatures as low as –110 F.

New Materials and Equipment

(CONTINUED)

New Steel Has Improved Machinability

A new steel has been developed which, according to the *Jones & Laughlin Steel Corp.*, Pittsburgh 30, can be machined 10 to 25% faster than the fastest standard free-machining Bessemer screw steel in commercial use today. The steel can now be furnished in cold-finished bars. It can be used in the manufacture of nuts, screws, studs, fittings, and other machined products.

Field tests in the development of this steel, known as "E" steel, show a machinability index as high as 170 compared to 135 for B-1113. In addition, this steel is said to have a smoother finish after machining, better cold working and cold forming properties, and gives longer tool life on screw machines than its predecessor.

A large producer of nuts stated production had been increased 15% over B-1113. Another nut manufacturer said production had been increased on certain machines from an average of 1607 pieces per hr. to 1832 pieces per hr., and tool life was doubled.

A loom manufacturer said production was increased 10% in two separate tests on different screw machines, and the product showed marked improvement in finish. Used in production of transmission parts, improved finish and satisfactory peening qualities were reported.

The new "E" steel is particularly suited for automatic screw machine products.

Three Developments in Plastics

Three new plastics developments have been announced recently by the *General Electric Co.*, Pittsfield, Mass. One of these is a new line of fast-curing phenolic molding powders. Developed to make it possible to lower the cost of wiring device parts, these general purpose powders are available in special granulations for high-speed automatic molding as well as in stock grades for conventional operations.

Because of their low specific gravity (1.37), these new molding powders are said to enable users to produce more parts per pound than is possible with higher gravity fast-curing materials. Other physical and electrical properties are equal to those found in typical general purpose compounds.

Another development is a new silicone insulating resin designed to enable electrical equipment to operate at temperatures as high as 356 F. Designated G-E Silicone Resin No. 9989-1, the thermosetting insulation has general application for impregnating spun glass and asbestos wire coverings and for binding coils, windings, and other motor, generator and transformer parts.

It has excellent dielectric strength as well as superior heat and water resistance. It dries tack free in less than 30 min. at relatively low temperature, and can be cured to a tough flexible film. The new silicone resin can be cured in conventional equipment at baking temperatures ranging up to 482 F. It has a solids content of 60% and an average viscosity of 200 cp. at 77 F.

The third development is a polyester-type plasticizer with outstanding heat and light resistance and a wide range of compatibilities. Designated G-E 2557, the material combines the desirable features of both polymeric and monomeric plasticizers. Though it is reported to be permanent, non-migrating, and oil and heat resistant, this plasticizer has a low viscosity for handling. It is compatible with polyvinyl chloride, polyvinyl chloride-acetate, chlorinated paraffin, chlorinated rubber, acrylic esters, nylon, alkyd resins, nitrocellulose, ethyl cellulose, and cellulose acetate-butyrate.

Typical polyvinyl chloride compositions with this plasticizer have shown no darkening in standard Fad-O-Meter tests after 148 hr. Eight-month exposures in Florida have revealed no checking nor darkening of polyvinyl chloride and nitrocellulose plasticized with the new material. After seven days at 250 F these compositions have shown a small increase in tensile strength with no decrease in elongation.

ALL IRON CASTINGS ON BLISS PRESSES ARE MEEHANITE METAL®

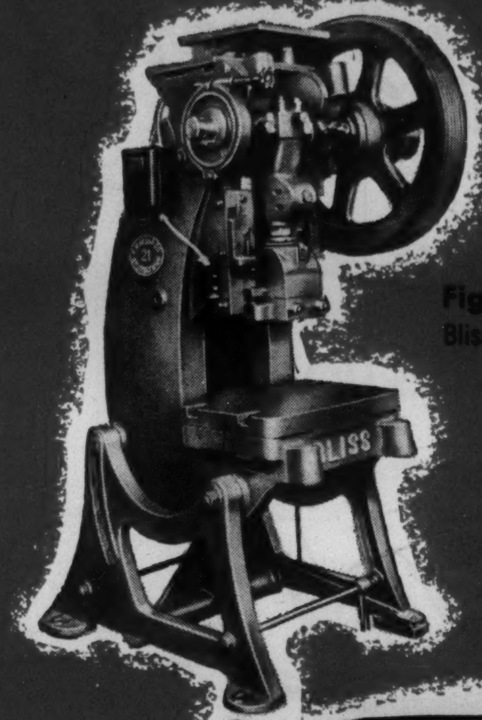


Figure 1
Bliss Inclinable Press.

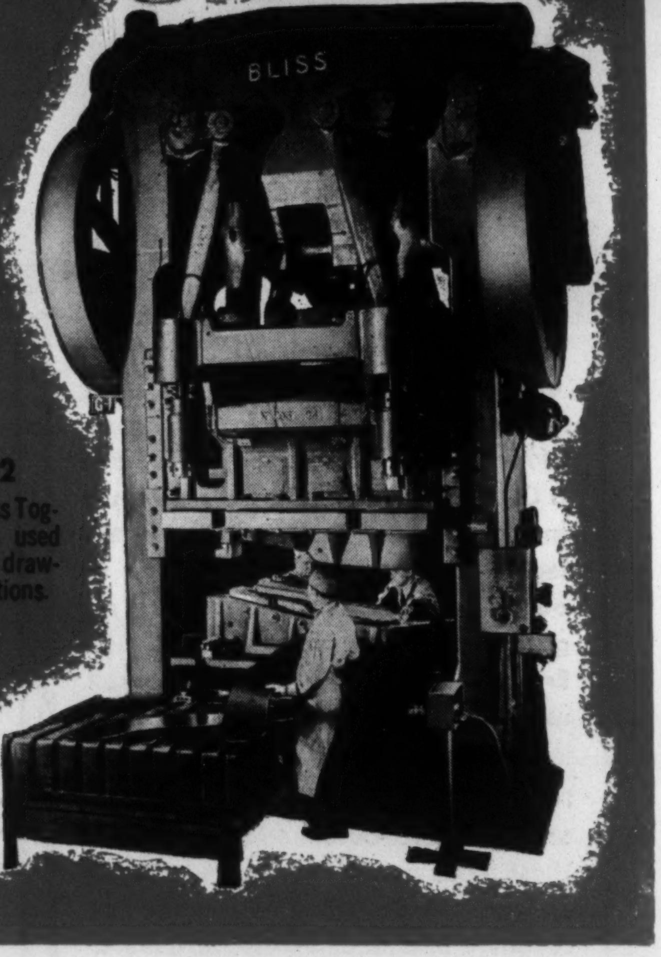


Figure 2
Large Bliss Toggle Press used for deep drawing operations.

E. W. BLISS COMPANY, Detroit, Michigan, prominent manufacturers of a line of mechanical and hydraulic presses as well as other machinery, operate two Meehanite foundries. The hundreds of tons of Meehanite castings produced in these plants are used as structural components for their products.

In their line of presses ranging from a small Inclinable Press, Figure 1, to the Giant deep-drawing Toggle Press, Figure 2, Meehanite castings are used for such important parts as frames, flywheels, brake and clutch housings, connections, slides, etc. Presses of these types must be rugged and must perform precision work. Their design must incorporate maximum rigidity for die life with a proper safety factor below the elastic limit of the structural material in order to be sure of eliminating permanent set. Meehanite castings provide these qualities accompanied by resistance to fatigue and impact, high compressive and tensile strength and excellent vibration absorption qualities.

For further facts about the importance of quality castings as units of construction write for the bulletin "The Vital Component—Good Castings." For a copy write to any of the foundries listed.

MEEHANITE FOUNDRIES

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
H. W. Butterworth & Sons Co.	Bethayres, Pennsylvania
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co.	Portland, Oregon
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
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Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
The Henry Perkins Co.	Bridgewater, Massachusetts
Johnstone Foundries, Inc.	Grove City, Pennsylvania
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Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis-Fensom Elevator Co., Ltd.	Hamilton, Ontario
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
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The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
U. S. Challenge Co.	Centerville, Iowa
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Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

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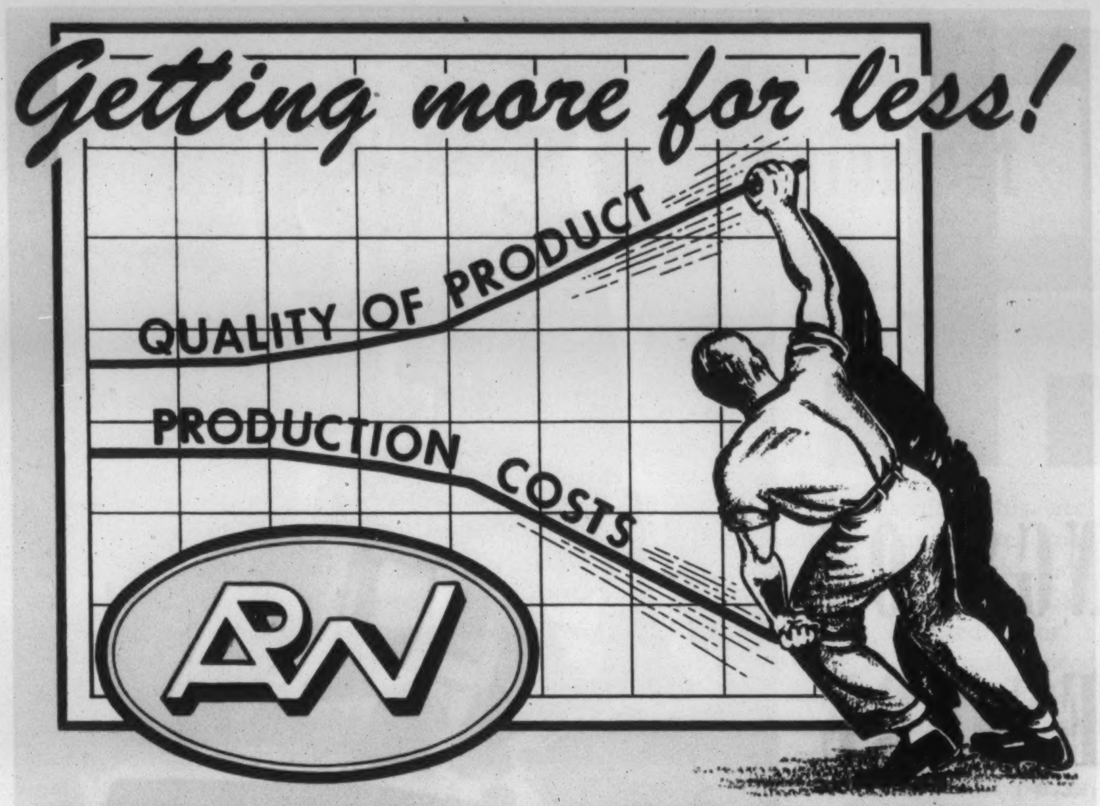

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FOR LOW TEMPERATURE BRAZING

Today's competitive production demands faster, more practical and less expensive methods. That is the basic reason for the constantly increasing use of APW Silver Brazing Alloys. We have a COMPLETE line and there is no silver brazing problem that cannot be handled to the best advantage by one of our products. If you are not sure regarding the most suitable APW Silver Brazing Alloy for your purpose, consult us and you will get prompt response.

Regarding APW Fluxes: Among the two most widely used are our No. 1100 and No. 1200 described at the right. These fluxes do NOT crystalize or harden and are smooth and creamy. For complete information write for Bulletin No. 45 and free samples. Fill in and return coupon below.

1100 LOW TEMPERATURE FLUX

A superior low-temperature flux for ferrous and non-ferrous metals. Doesn't lump or harden; removes readily in cold water

•

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A fine all-purpose flux, equally good for dipping and brushing at lower or higher temperatures. For ferrous and non-ferrous metals.

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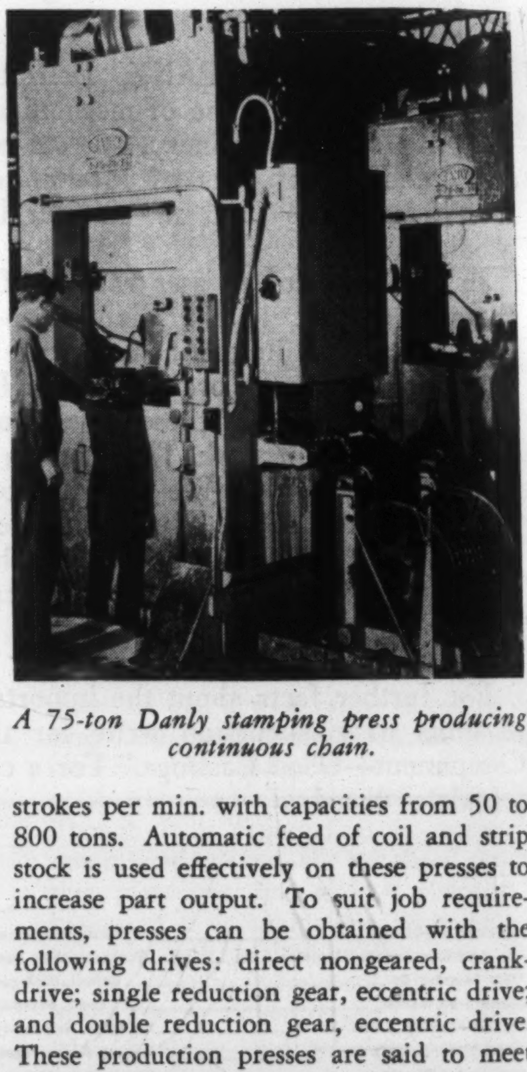
New Materials and Equipment

New Presses for Metals and Plastics Forming

Stamping Presses

A line of medium to high tonnage mechanical presses is now offered by the *Danly Machine Specialties, Inc.,* Chicago. These presses are designed especially for stamping operations employing standard, progressive, or multiple dies.

The broad range of these mechanical presses in various sizes and types includes high production units having speeds to 250 strokes per min. with capacities from 50 to 800 tons. Automatic feed of coil and strip stock is used effectively on these presses to increase part output. To suit job requirements, presses can be obtained with the following drives: direct nongeared, crankdrive; single reduction gear, eccentric drive; and double reduction gear, eccentric drive. These production presses are said to meet the stamping requirements of the automotive, electrical, agricultural appliance, and other industries.



A 75-ton Danly stamping press producing continuous chain.

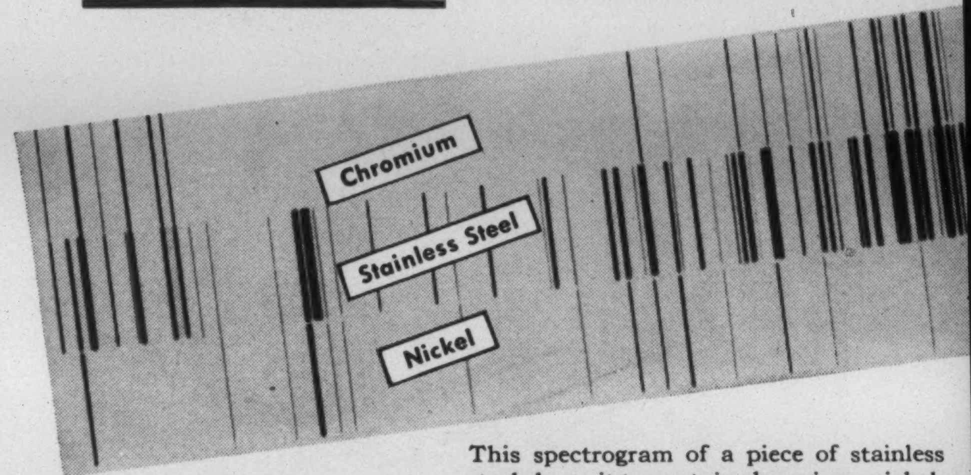
Resin and Abrasive Materials Presses

Specially designed for molding fast-curing alkyd resins is a new fully automatic press, Model 200-H, announced by the *F. J. Stokes Machine Co.,* 5972 Tabor Rd., Philadelphia, Pa. Featuring high-speed ram travel, this new automatic press is said to have increased output 450% in a high production automotive part. Production was

(Continued on page 102)

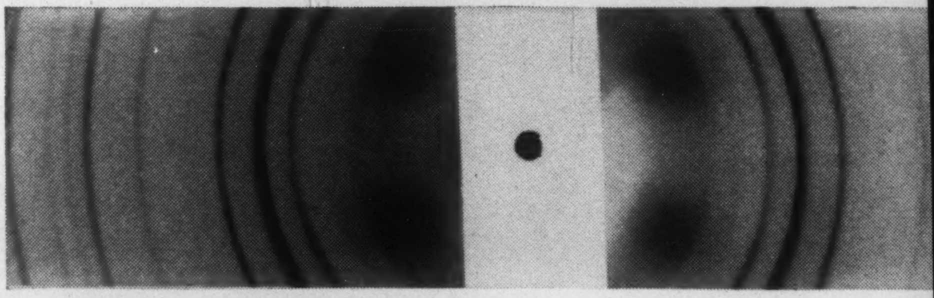
3 ways photography shows composition of materials

Spectrography . . . To record composition quantitatively and qualitatively, Kodak offers 108 specialized materials. For general spectrographic use, however, Kodak recommends two emulsions: *Kodak Spectrum Analysis No. 1 Plates and Films* for high contrast, low background density, and low granularity; and for a more uniform contrast-wavelength relation, *Kodak Spectrum Analysis No. 2 Plates and Films.*



This spectrogram of a piece of stainless steel shows it to contain chromium, nickel, and iron, but none of the other alloying elements commonly found in commercial stainless steel.

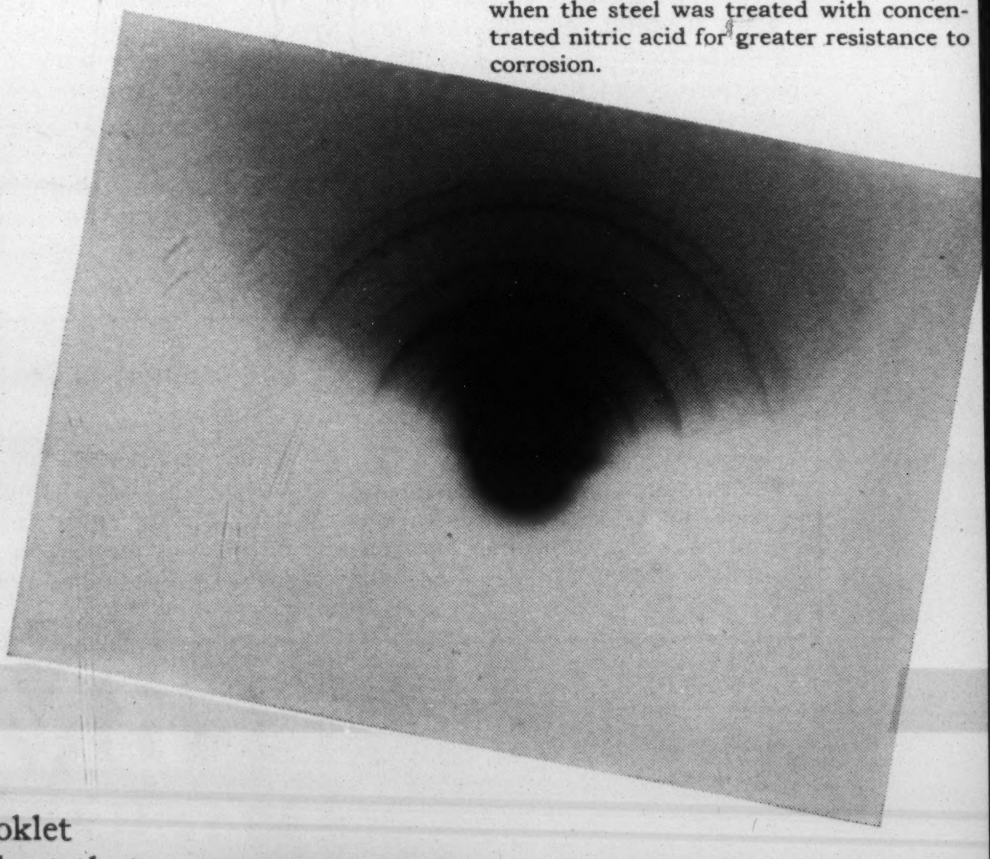
X-ray diffraction . . . To record crystalline composition, stresses, and thermal history by x-ray diffraction, the fastest film to use is *Kodak Industrial X-ray Film, Type K.* When smooth microdensitometer traces rather than highest film speed are required, use fine-grain *Kodak Industrial X-ray Film, Type A.*



This x-ray diffraction pattern shows, by the density variations along the Debye-Scherrer rings, notably by the patchy center, that the stainless steel used above is not isotropic in its properties.

Electron diffraction . . . To record the nature and composition of thin films, layers, surface reaction products of materials by electron diffraction, Kodak offers the following products: *Kodak Medium Lantern Slide Plates,* and *Kodak Contrast Lantern Slide Plates,* and for the most critical work, *Kodak Spectroscopic Plates, Type 548-0.* Users also report that many highly informative electron diffraction patterns have been recorded on *Kodak Verichrome Film.*

This electron diffraction study (below) of the surface of the same stainless steel shows the presence of a thin layer, formed when the steel was treated with concentrated nitric acid for greater resistance to corrosion.



Kodak will send you free: a copy of the booklet "Materials for Spectrum Analysis" and a chart that tabulates Kodak films for x-ray diffraction. Your specific questions on Kodak Lantern Slide Plates for electron diffraction, and on other products mentioned above, will gladly be answered by correspondence.

Eastman Kodak Company, Rochester 4, N. Y.

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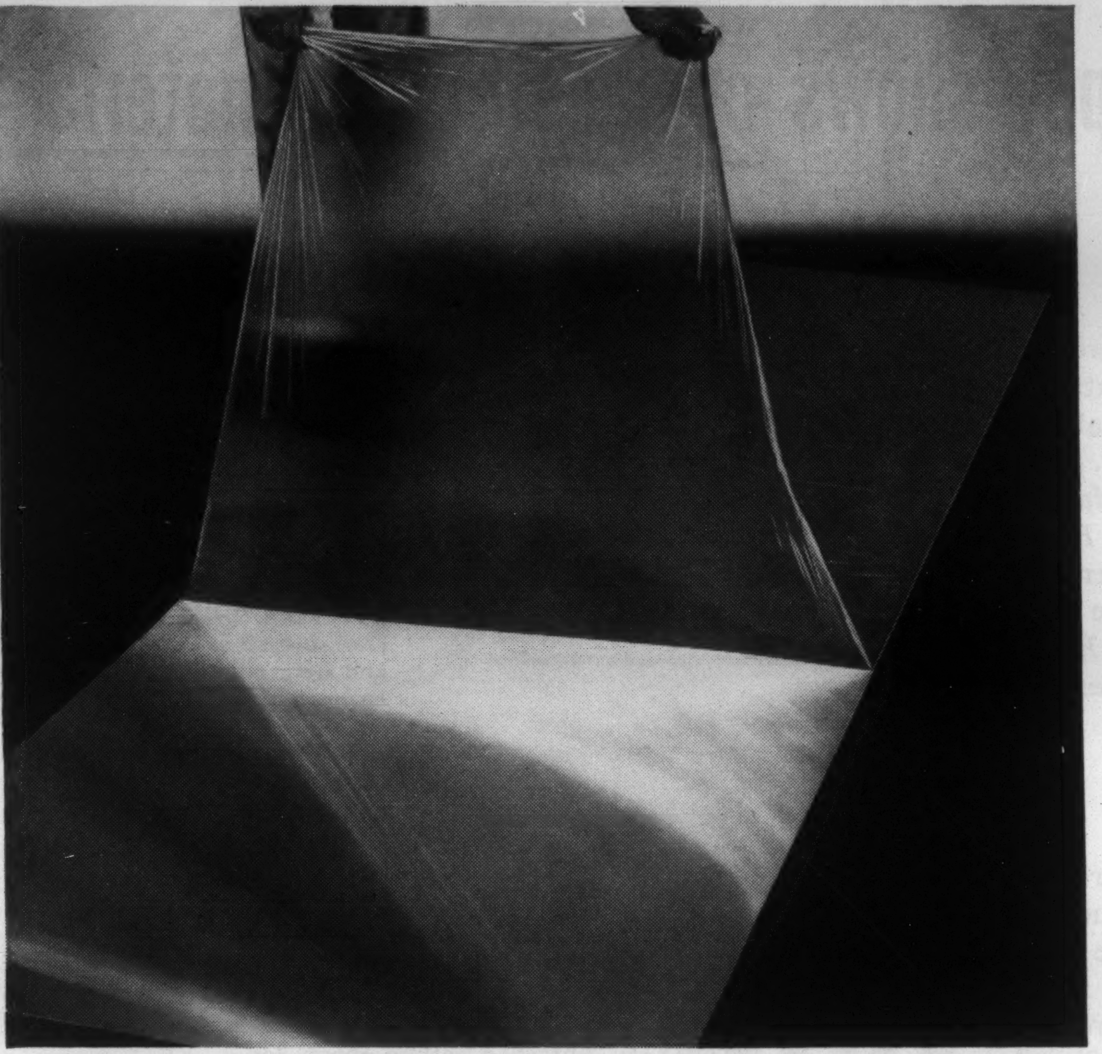
ANOTHER 3M COMPANY NEWS STORY



REMOVING STRIPPABLE COATING from stainless steel blank in one quick step. Note tough, cohesive film which will stop marring of metal all through forming operations.

New protective coating sprays on, strips off

CUTS COSTLY POLISHING OF FINE SURFACES AFTER PUNCHING, ROLLING, FORMING

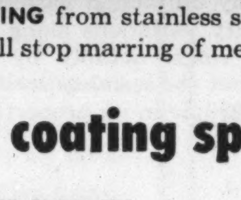
Eliminate buffing and polishing operations—which often amount to more than the cost of the formed pieces—with this new 3M Strippable Coating EC-968.

Just spray it on. It dries in 2 minutes to a film that resists abrasion, water, grease and weathering—a translucent bronze-colored coating that gives metal full protection all the way from mill to fabricator, to consumer.

Get complete information about this sure, fast, economical way to guard fine metal surfaces. Write us today, asking for literature or the services of a Field Engineer. No obligation.

QUICK FACTS ABOUT EC-968 Strippable Coating

- **FAST**—spraying, drying, stripping only a matter of minutes.
- **ECONOMICAL**—prevents metal marring in cold-forming operations; prolongs the life of dies and rolls; makes excessive usage of die lubricants unnecessary.
- **GOOD COVERAGE**—200-225 square feet per gallon for a 1 mil film.
- **NON-BLOCKING**—to itself or to metal even under long storage or high stacking or great pressure.



3M BRAND ® STRIPPABLE COATING

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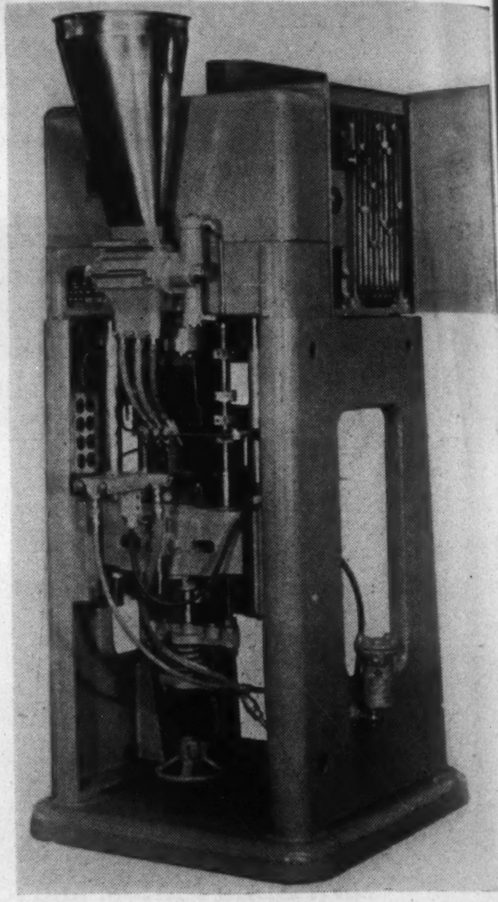
General Export: DUREX ABRASIVES CORP., *New Rochelle, N. Y.*
In Canada: CANADIAN DUREX ABRASIVES LTD., *Brantford, Ontario*

New Materials and Equipment

increased from four per min. (using general purpose materials molded on a conventional press) to 18 per min. in alkyd resin on the new press. The high speed of the machine is shown by the fact that it completes three cycles per min.

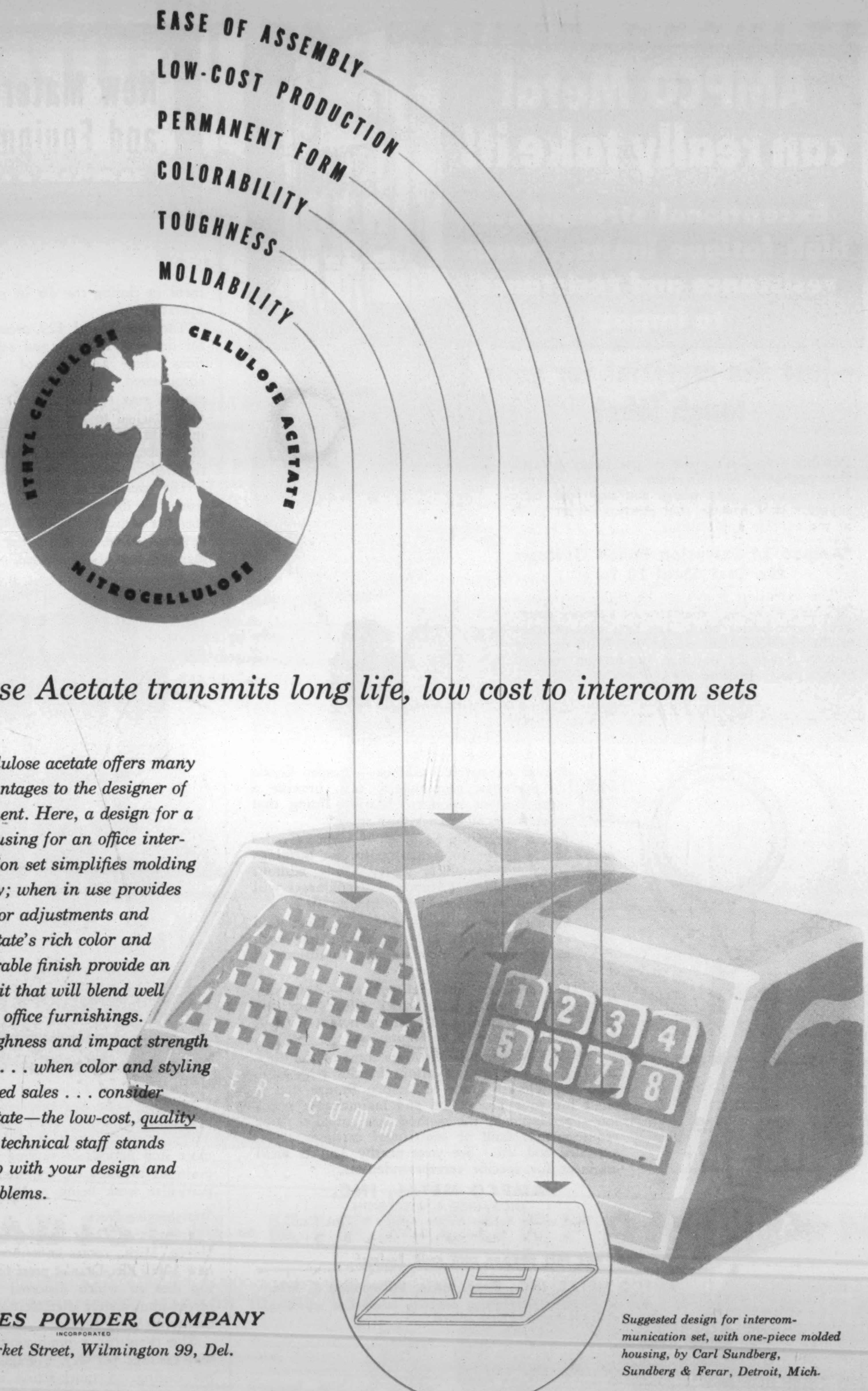
Another new press introduced by Stokes is a special high-speed rotary compressing machine designed for handling abrasive materials such as powdered glass, ceramics and powdered metals. Compressed parts up to ½ in. in dia. can be produced at rates up to 300 parts per min. on this B-2X press. In addition to compressing a wide assortment of shapes and sizes, the special press can be arranged to produce parts having cored holes, etc. With a 1-h.p. gear head motor mounted vertically above the die area of the press, the possibility of abrasive material working into and damaging the motor is eliminated. Special guards protect the upper punches from excessive wear. The press applies up to 2½ tons of pressure from above and below simultaneously.



This Stokes press is fully automatic and designed for fast-curing alkyd resins.

Air Powered Press

The *Taber Instrument Corp.,* 109 Goundry St., North Tonawanda, N. Y., is producing a press powered by compressed air with hydraulically controlled ram movement with electronic timing features which provide an adjustable preset rate of move-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LOW-COST PRODUCTION
PERMANENT FORM
COLORABILITY
TOUGHNESS
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Cellulose Acetate transmits long life, low cost to intercom sets

Versatile cellulose acetate offers many product advantages to the designer of office equipment. Here, a design for a one-piece housing for an office intercommunication set simplifies molding and assembly; when in use provides easy access for adjustments and repairs. Acetate's rich color and lustrous, durable finish provide an attractive unit that will blend well with modern office furnishings.

When toughness and impact strength really count . . . when color and styling spell increased sales . . . consider cellulose acetate—the low-cost, quality plastic. Our technical staff stands ready to help with your design and material problems.

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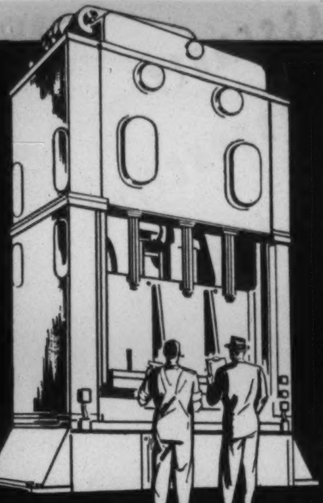
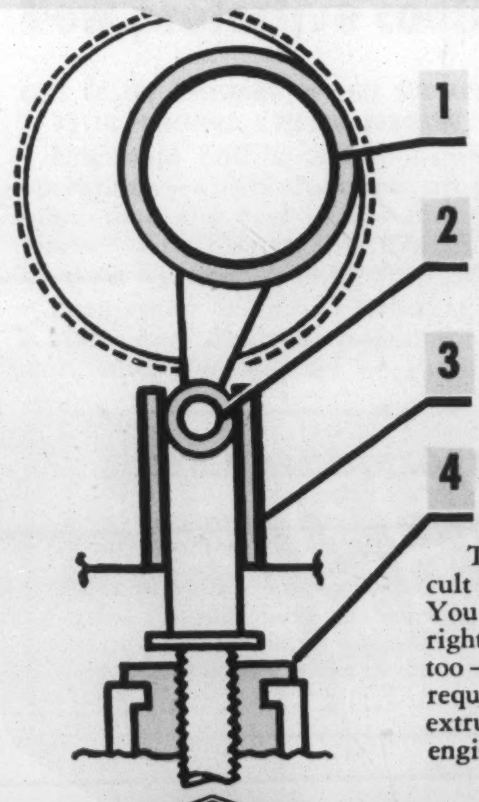
Suggested design for intercommunication set, with one-piece molded housing, by Carl Sundberg, Sundberg & Ferar, Detroit, Mich.





AMPCO Metal can really take it!

Exceptional strength... high fatigue limits... wear resistance and resistance to impact

—just the material for your tough jobs!

Possibly you don't make or use heavy presses. But probably you *do* have jobs for Ampco Metal — tough jobs where you need the same superior performance that Ampco Metal gives in these press applications.

***Ampco 24 Extrusion Punch Outlasts the Best Steel 10 to 1**

The extrusion punch at the right extrudes a 5/8" hole to a 3¼" diameter in a heavy gauge steel water heater head. The best steel punches produced 6600 pieces *maximum*. With the new Ampco Grade 24 punches, production runs of 65,000 pieces became *average* on this job.

Ampco Bronze in the Press itself!

1. **Bronze eccentric bushings** — Ampco Grade 12 Bushings, centrifugally cast, provide a wear-resistant eccentric bearing lining that gives maximum heavy-duty service.
2. **Bronze wrist-pin bushings** — Ampco Grades 18, 18-23, or 20 centrifugally cast bushings withstand extremely heavy loads without mushrooming. (Ampco field engineers will be glad to recommend proper grade.)
3. **Bronze-lined guides** — Ampco 8 Sheet used as liners (gibs) give maximum life with minimum wear under varying conditions of load, speed, etc.
4. **Bronze liner and locking nut** — Ampcoloy E-123 (centrifugally cast) affords up and down adjustment of shutting height without galling and with minimum wear.

These few examples illustrate some of the difficult jobs which Ampco alloys handle with ease. You can select a grade of Ampco Bronze that is right for your production and maintenance needs too — produced by the method best suited to your requirements: sand or centrifugal castings, sheet, extruded rod, etc. See your nearby Ampco Field engineer for specific recommendations.

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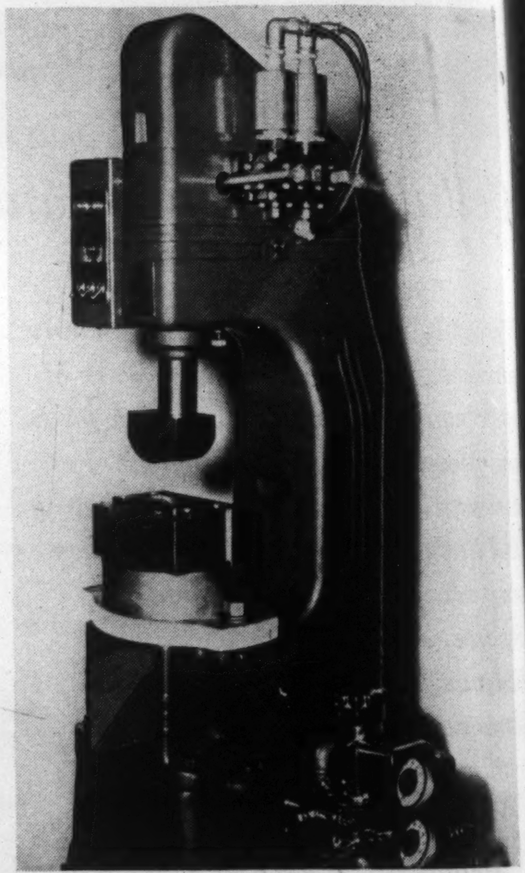
New Materials and Equipment

ment in closing the die or performing an operation.

The new Model 129 press is adaptable for drawing, forming and assembly operations where a variety of conditions are encountered. For instance, an assembly operation may require a fast traverse of the tool attached to the ram to a point 1/16 in. above an operation, then a slow powerful stroke up to 2 tons of pressure will be required to perform the operation.

The pressure of the ram is adjustable from 100 lb. to 2 tons. The rate of ram travel is adjustable from 1000 in. per min. down to 10 in. or less per min. by simple manipulation of the controlling valves. The electronic control panel provides for one or more stop periods of varying duration for positions to meet the requirements of the particular work being performed.



A feature of this Taber press is the hydraulically controlled ram movement.

Straightening Press

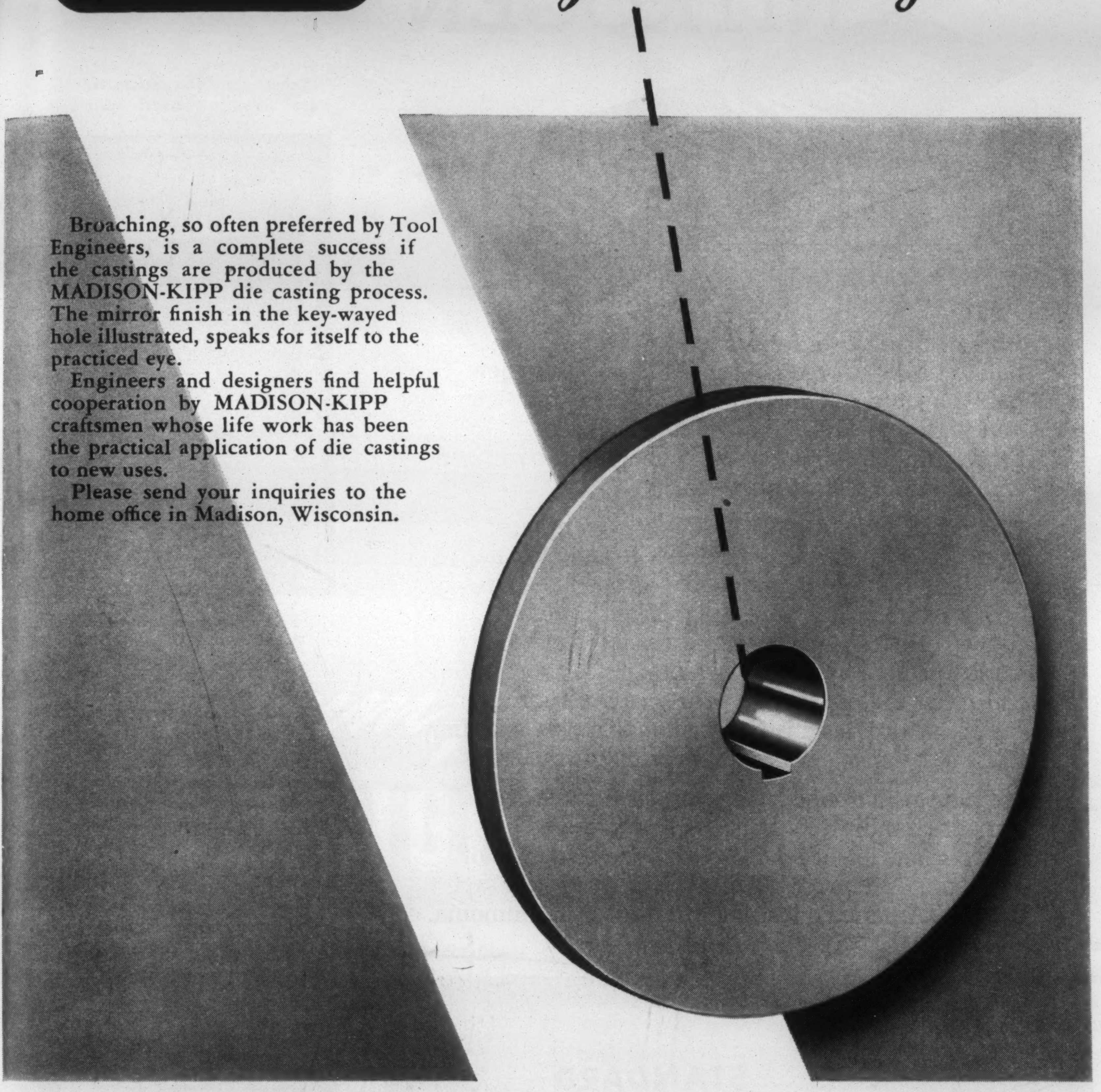
From the *Dake Engine Co.*, Grand Haven, Mich., comes announcement of the new 50HE Elec-Draulic press for straightening dies in which distorted castings are placed immediately after their removal from the normalizing furnace.

The press has a production capacity of 400 castings per day, averaging 1.6 min. per casting. A quick-acting release valve eliminates turning on and off of the motor for each pressing operation.

EXCELLENT BROACHING RESULTS

with the

MADISON-KIPP *dense zinc die castings*



Broaching, so often preferred by Tool Engineers, is a complete success if the castings are produced by the MADISON-KIPP die casting process. The mirror finish in the key-wayed hole illustrated, speaks for itself to the practiced eye.

Engineers and designers find helpful cooperation by MADISON-KIPP craftsmen whose life work has been the practical application of die castings to new uses.

Please send your inquiries to the home office in Madison, Wisconsin.

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HYDROGEN and NITROGEN

from AMMONIA

Barrett Standard Anhydrous Ammonia, 99.95% NH_3, oxygen free, with a very low dew point, is an economical source of pure hydrogen and nitrogen. When dissociated, each pound produces approximately 34 cubic feet of hydrogen and 11 cubic feet of nitrogen.

Engineers have discovered many advantages from the use of dissociated anhydrous ammonia in the production of controlled atmospheres in furnaces for bright annealing, clean hardening, copper brazing, sintering, reduction of metallic oxides, atomic hydrogen welding, radio tube sealing and other metal-treating practices. Anhydrous ammonia also has unsurpassed qualities in nitriding of steel, used as ammonia gas or dissociated.

Metallurgists are effecting real economies by using Barrett Standard Anhydrous Ammonia as a replacement for other more expensive sources of hydrogen and nitrogen. For information, contact Barrett, America's leading distributor of ammonia.

Barrett

STANDARD
ANHYDROUS AMMONIA

Barrett Standard Anhydrous Ammonia is available in 50, 100 and 150-pound cylinders from stock points located from coast to coast.

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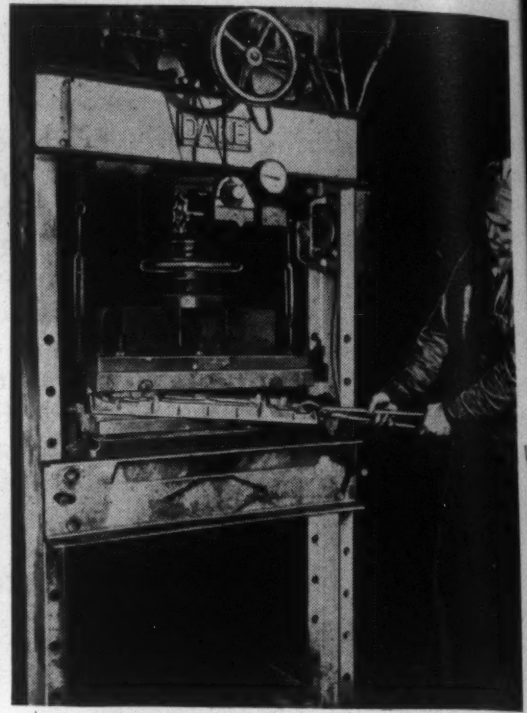
ALLIED CHEMICAL & DYE CORPORATION
40 RECTOR STREET, NEW YORK 6, N. Y.

New Materials and Equipment

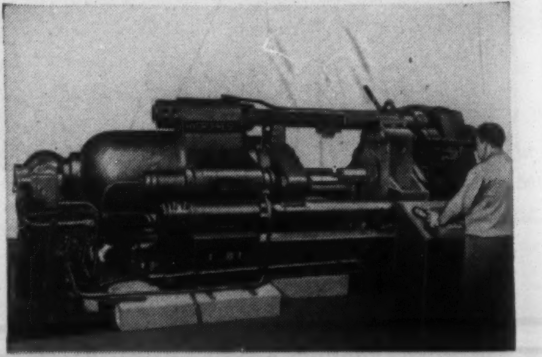
Other features include an adjustable safety valve to protect against overload, variable-speed ram, movable workhead, an eye-level height pressure gage, adjustable table, and auxiliary screw-type ram.



An iron casting in the process of being straightened in the new Dake press.

Extrusion Press

A new type oil-hydraulic extrusion press for production of rods and shapes from light metals and other nonferrous alloys has been designed by *Hydropress, Inc.*, 570 Lexington Ave., New York. The self-contained machine, which is built in 500- and 1000-ton capacity, requires little floor space and minimum operating personnel. A production of 50 to 60 billets per hr. can be obtained.



This Hydropress press is designed for production of rods and shapes from light metals and other nonferrous alloys.

The press is particularly suited for aluminum and other light metal extrusions such as window sections, ladder sides, trim moldings, ornamental and structural shapes. The press is designed for accessibility and quick change of dies.

This progressive die often needed [illegible] before Lehigh H was used. Now the die rarely needs attention more than once in six weeks. And it produces a much better surface on the door knobs which it blanks and draws from .035-in. steel or brass.

Photos courtesy of Skillman Hardware Manufacturing Co., Trenton, New Jersey.

A draw die of Lehigh H assures maximum production in shaping door knob parts on this 35-ton power press.

For maximum production it's LEHIGH H tool steel

"High-carbon, high-chromium" is a brief description of Lehigh H. But it's outstanding as a tool steel for maximum production because it combines these three big features:

- ★ Maximum Wear-Resistance
- ★ Air-Hardening for Safety and Minimum Distortion
- ★ Deep-Hardening with High Compressive Strength

Lehigh H is a tool steel that just can't be surpassed when you have a tool and die job involving one or more of the following requirements: *Long Runs, Close Tolerances, Safe-Hardening, Severe Service.*

Make your tools and dies from Lehigh H for blanking, forming, drawing, punching, shearing and bending. And it's a top-choice steel for lamination dies, shear blades, wearing plates, gages, bending rolls, and the like.

Lehigh H is stocked in popular sizes by Bethlehem Tool Steel distributors in principal cities. The nearest Bethlehem sales office can give you full information. Better still, order a test piece for a trial in your own shop.

	C	Cr	V	Mo
Typical Analysis:	1.55	11.50	0.40	0.80

Working Hardness: Rockwell C-58 to 62

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BETHLEHEM STEEL

LEHIGH H . . . one of Bethlehem's Fine Tool Steels

Quality

CASTINGS

in...

MEEHANITE®
ABK METAL
GRAY IRON

(plain or alloy)

- American Brake Shoe research and advanced foundry techniques can benefit you. When you refer your requirements to Brake Shoe, you get sound, clean, metallurgically correct castings, and machined rejects are low. You also receive the advantage of impartial recommendations as to metal types, such as:

Meehanite® — a series of controlled irons in 3 general groups to meet specific requirements; general engineering, heat resistant, corrosion resistant.

ABK Metal — a premium grade alloyed iron with outstanding abrasion resistance.

Engineered Gray Iron — a series of engineering cast irons with controlled properties and good machinability.

At Brake Shoe's large and well-equipped production foundries in Mahwah, N. J., Melrose Park, Ill., and Baltimore, Md., castings of widely used types can be made — light, medium or heavy weight, green or dry sand, or all core assemblies — as well as difficult or special purpose types.

Whatever your present or future needs for cast parts may be, send your specifications to Brake Shoe for expert recommendations.

7551

AMERICAN Brake Shoe COMPANY

BRAKE SHOE AND
CASTINGS DIVISION
230 PARK AVENUE, NEW YORK 17, N. Y.

New Materials and Equipment

Improved Annealing Gas Produced by New Generator

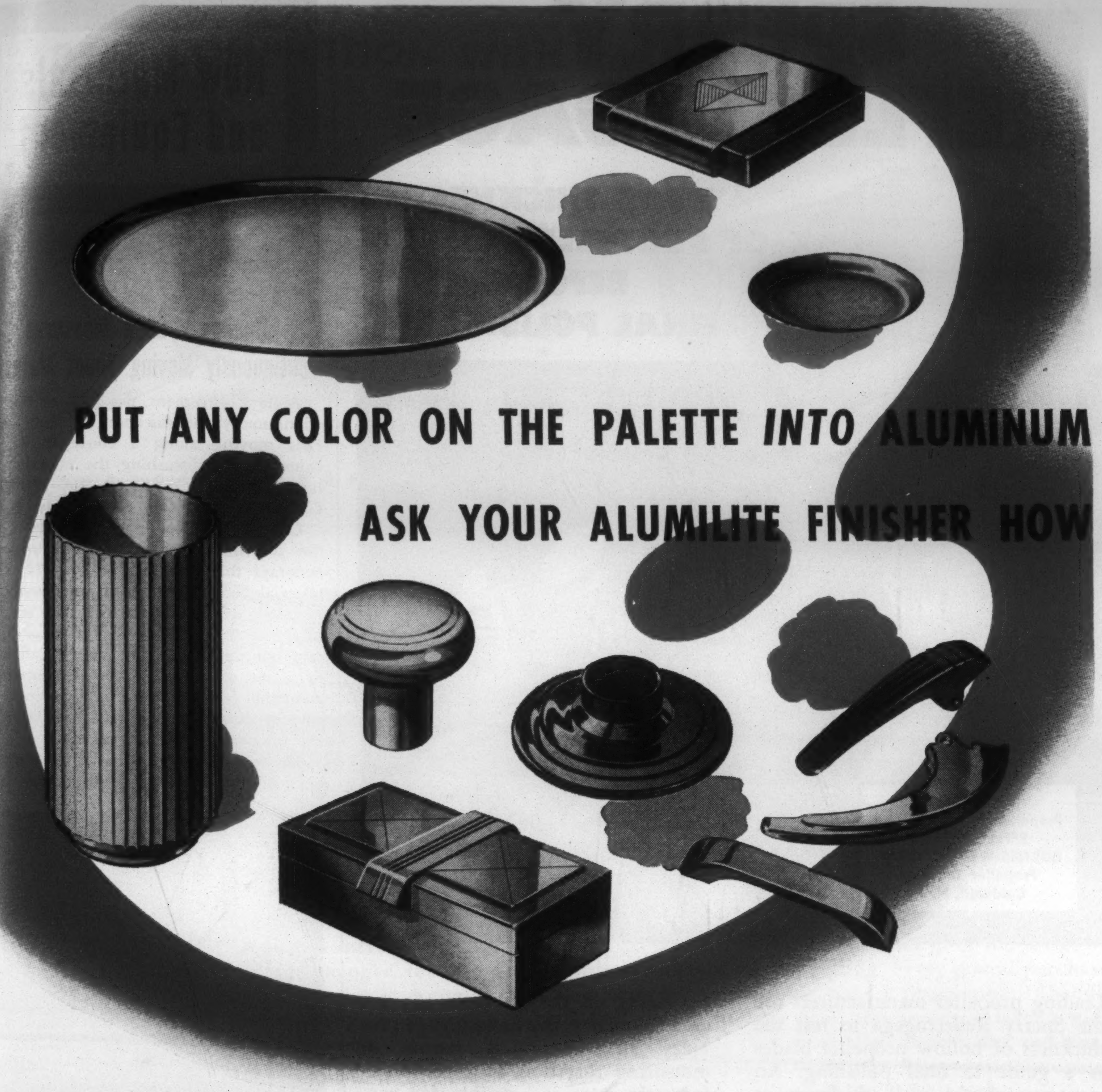
A new generator designed to produce an annealing gas whose composition can be accurately varied has been introduced by *Baker & Co., Inc.*, East Newark, N. J. The new generator, called Nitroneal, effects in one operation an interaction of anhydrous ammonia with air in the presence of an Engelhard catalyst to form nitrogen and hydrogen. The hydrogen content is controlled within a range of from ½ to 25% to meet the requirements of any particular furnace load, and maintained at the determined figure within close tolerance.

According to the company, a prime advantage of the new unit lies in its cost saving. On the basis of $2.80 for cylinders of nitrogen or annealing gas of 200 cu. ft. maximum capacity, or $14.00 per 1000 cu. ft., savings amount to more than $2.30 per cylinder, or about $12.00 per 1000 cu ft. This is estimated on the basis of using cylinder ammonia for operating the generator. However, if tank car ammonia is used to operate the generator, the cost of the finished gas is reduced to about 40¢ per 1000 cu. ft.

Operation was described as being accomplished by feeding air and liquid ammonia to the generator at room temperature and at pressures of approximately 10 to 20 lb., respectively. The finished annealing gas comes from the unit at only slightly above room temperature at a pressure of 1 lb. or more, as desired. It is saturated with water vapor, which is readily removable by any standard dryer.

The generator is a complete, self-contained unit, requiring no power supply except for instrumentation. It can be supplied with capacities of finished gas ranging from 100 to 10,000 cu. ft. an hr. The catalytic conversion of the raw materials is said to eliminate all explosive mixtures, and the gas composition leaving the generator remains constant within 1% of the set point. This is verified by a direct reading meter.

- The *United States Products Co.*, 518 Melwood St., Pittsburgh 13, has developed three different grades of abrasive compounds specifically for use in grinding and lapping-in brass or bronze tapered plug or key cock valves. These compounds are made with a water soluble base that has excellent lubricating and carrying qualities. Parts finished with this compound can be washed in ordinary water. Made in the following grades: No. 17, coarse; No. 18, medium; No. 19, fine.


PUT ANY COLOR ON THE PALETTE *INTO* ALUMINUM
ASK YOUR ALUMILITE FINISHER HOW

Rich blue *in* the aluminum case for a hearing aid . . . bright red *in* the aluminum handles to keep garden shears from hiding in the green grass . . . all of them color-finished by the patented Alumilite process that seals the color into the metal surface. The Alumilite process gives aluminum a harder, longer-wearing surface, lets you pick the colors that will increase the sales appeal of the things you make from Alcoa Aluminum. Your choice of any color and pastel shades, as well as natural aluminum, gold, brass, bronze and other metallic effects.

Your nearby Alumilite licensee is set up to give you prompt and dependable service on the Alumilite process for your articles. If you don't know who your local Alumilite licensee is, write to us. We'll be glad to acquaint you. Write to ALUMINUM COMPANY OF AMERICA, 662 Gulf Building, Pittsburgh 19, Pennsylvania. Sales offices in 55 leading cities.

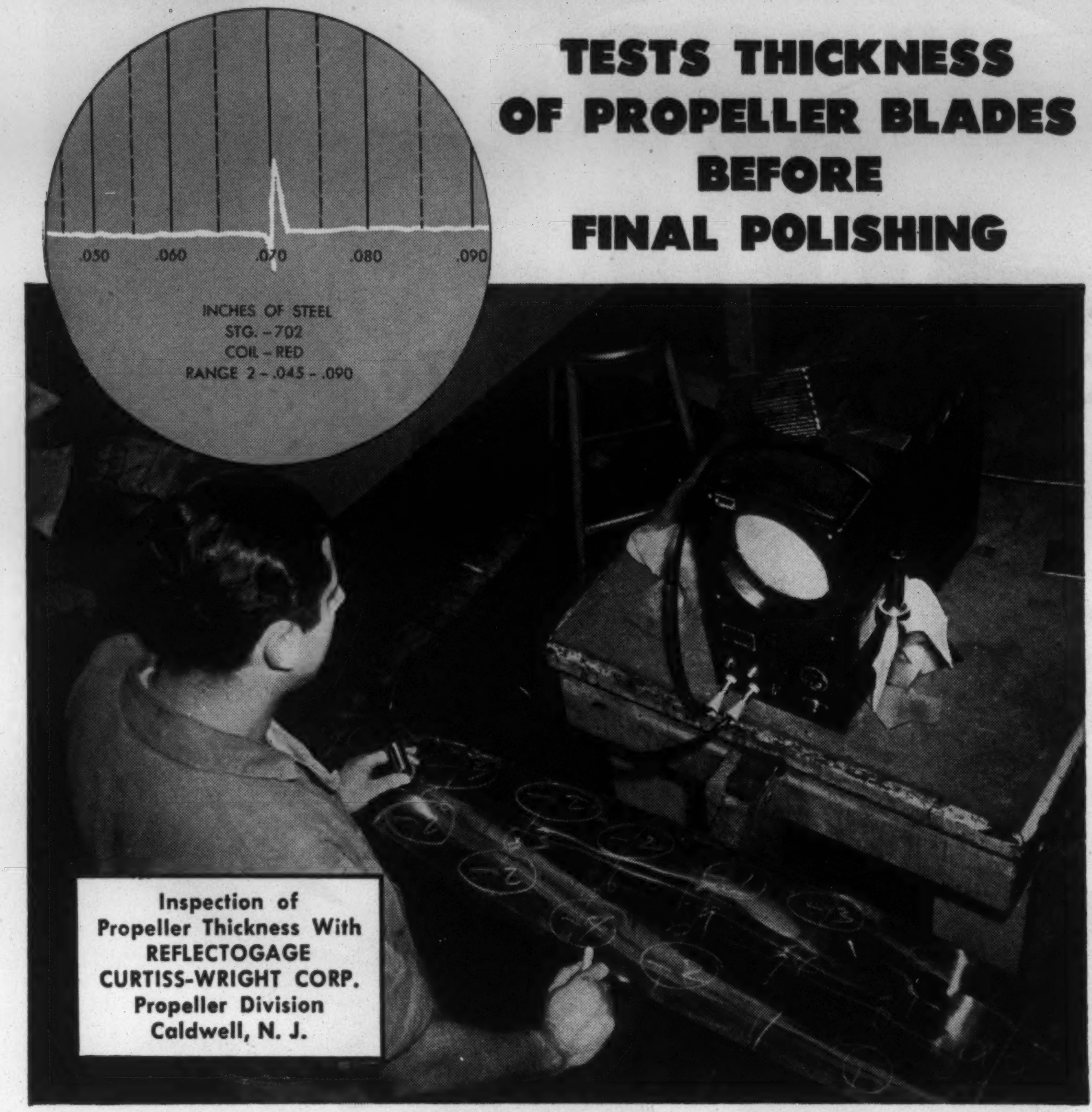
ALCOA FIRST IN ALUMINUM

REG. T. M.

ALCOA
A C O A
ALUMINUM

SPERRY REFLECTOGAGE

TESTS THICKNESS OF PROPELLER BLADES BEFORE FINAL POLISHING



Inspection of Propeller Thickness With REFLECTOGAGE
CURTISS-WRIGHT CORP.
Propeller Division
Caldwell, N. J.

Leading propeller manufacturers use the Sperry Reflectogage to test the thickness of hollow propeller blades as a guide to final polishing. An inspector checks wall thickness at each blade station. This careful inspection provides a control of wall thickness throughout the blade within established wall thickness limits.

Propeller blades are only one of a large variety of fabricated parts which can be measured by the Sperry Reflectogage. Others include long tubes, formed hollow parts, blades and sheet stock, large tanks and boilers.

Operating on the principle of resonant frequency, the Reflectogage provides an economical means of measuring thickness of parts which formerly were inaccessible for convenient measurement.

In steel, the Reflectogage measures *directly* from .025 to .300 in. thickness, *indirectly* up to 4 in. Other metals and plastics can also be measured. Access from only one side is required. Accuracy is within plus or minus two per cent.

For full information on the Sperry Reflectoscope, write for your free copy of Bulletin 3700. F-4

SPERRY REFLECTOSCOPE

Instantly, accurately locates smaller defects . . . penetrates deeper into metals than any other non-destructive testing device. Saves valuable time lost in machining defective material, minimizes rejects. Read all the facts on the Sperry Reflectoscope in Bulletin 3001. F-4

SP-143

SPERRY

SPERRY PRODUCTS, INC.
DANBURY, CONNECTICUT

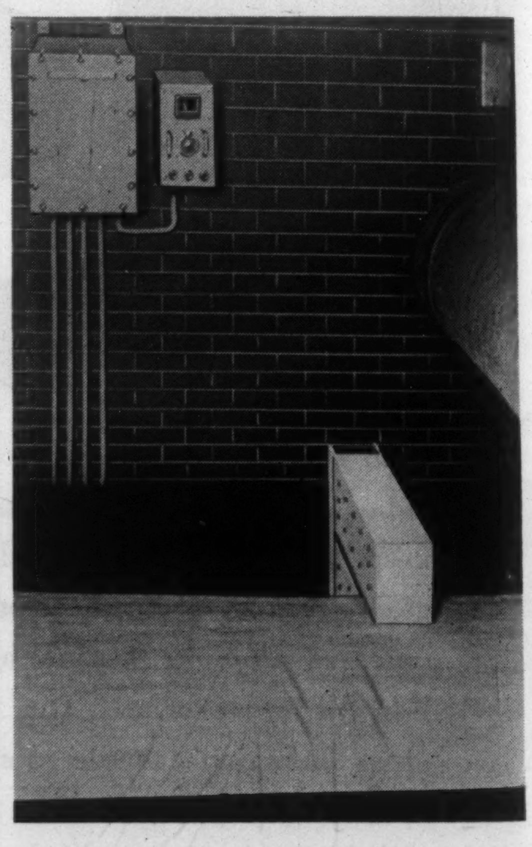
New Materials and Equipment

Thickness Gage Measures Continuously Moving Sheet Materials

A new instrument, designed to measure continuously the thickness of sheet materials moving along a conveyor without contacting or disturbing the material, has been announced by *Special Products Div., General Electric Co.*, Schenectady, N. Y.

Called the Beta-Ray Thickness Gage, the instrument measures the amount of beta-rays that are absorbed by the sheet material being checked. By measuring absorption, the device actually indicates the mass per unit area of the material under test, but the equipment can be calibrated in terms of thickness to help operators maintain product uniformity, reduce the amount of rejected material, and save on the amount of raw material used.

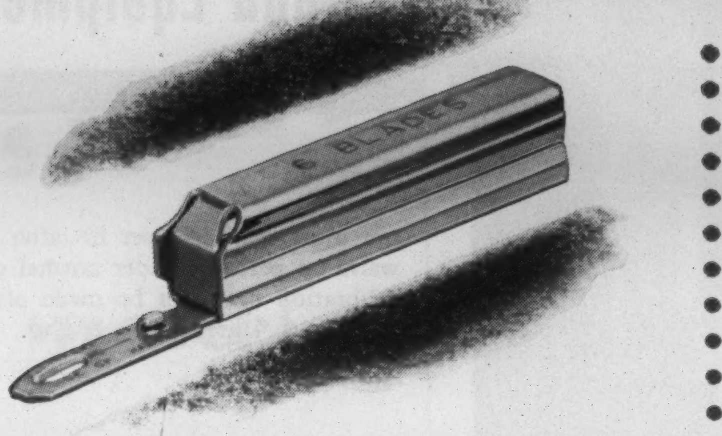
The new gage will find application in monitoring the thickness of metal foils, such as aluminum, copper, tin, brass and steel, being rolled at high speeds. It can also be used with plastics, textiles, rubber, and other sheet materials, especially those which cannot be contacted because of their condition while in processing.

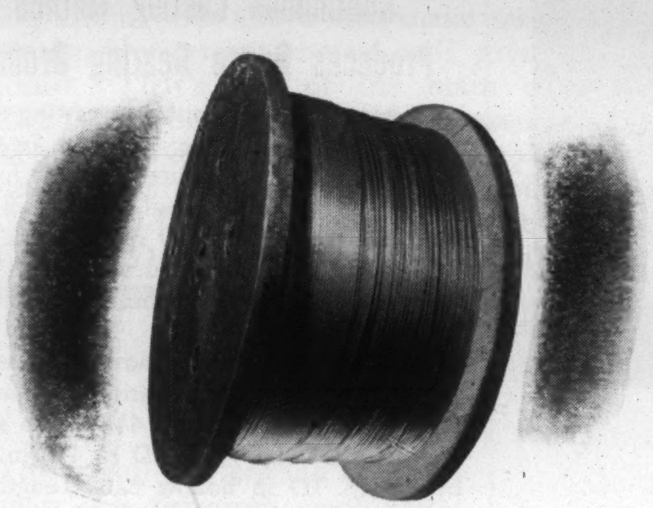


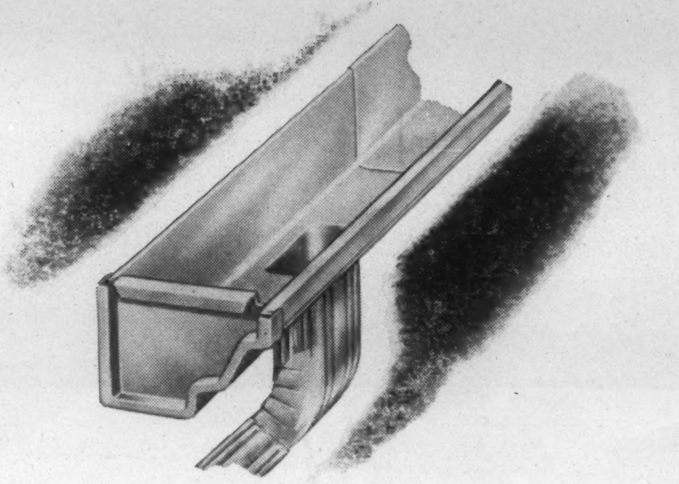
The Beta-Ray Thickness Gage shown measuring sheet material.

Operating on a power supply of 100 to 125 v., 60 cycles, ±0.3 cycles, power consumption of the gage is about 150 watts. Accuracy is ±2% or better between normal periods of calibration, while drift is

BEAT COMPETITION WITH IMAGINATION ... REDESIGN WITH ALUMINUM







● You're looking at ideas. Each of these redesigned products is a story of lower costs and increased appeal to consumers. That automatic blade changer, for instance, in naturally attractive aluminum eliminates a corrosion-resistant coating operation. The change from brass also provides a substantial material economy.

The beverage case is lighter, stronger, more attractive, now that aluminum serves instead of wood. It is made without bolts, rivets or welds. The cost per trip is lower. And it is easier to keep clean.

Aluminum cable, steel reinforced, is ending a shortage and bringing electric power to thousands of families for the first time. Aluminum costs less than copper and the lighter weight permits longer spans for reduced stringing costs.

Replacing galvanized and copper for gutters and downspouts, aluminum provides the long life of one at a cost comparable to the other. Simple mechanical joints do away with soldering.

Many of the products you see daily can be improved through the use of aluminum. This modern metal lends itself to modern design. Aluminum is ⅓ the weight of ordinary metals, yet it is strong. Every pound purchased offers three times the material for production. It handles faster, gives products a smart appearance. It takes a wider range of finishes than most other metals. But red-rust is never a problem, so finishing cost is frequently eliminated.

Reynolds Aluminum and its many alloys probably have a place in your designs—why not find out now. For the name of your local distributor or nearest Reynolds Sales Office, look under the "Aluminum" listing in your classified telephone directory or write to Reynolds Metals Company, Aluminum Division, 2500 South Third Street, Louisville 1, Kentucky.

ALUMINUM ALLOY DATA

This informative booklet is free when requested on your company letterhead. Just write to address at left.

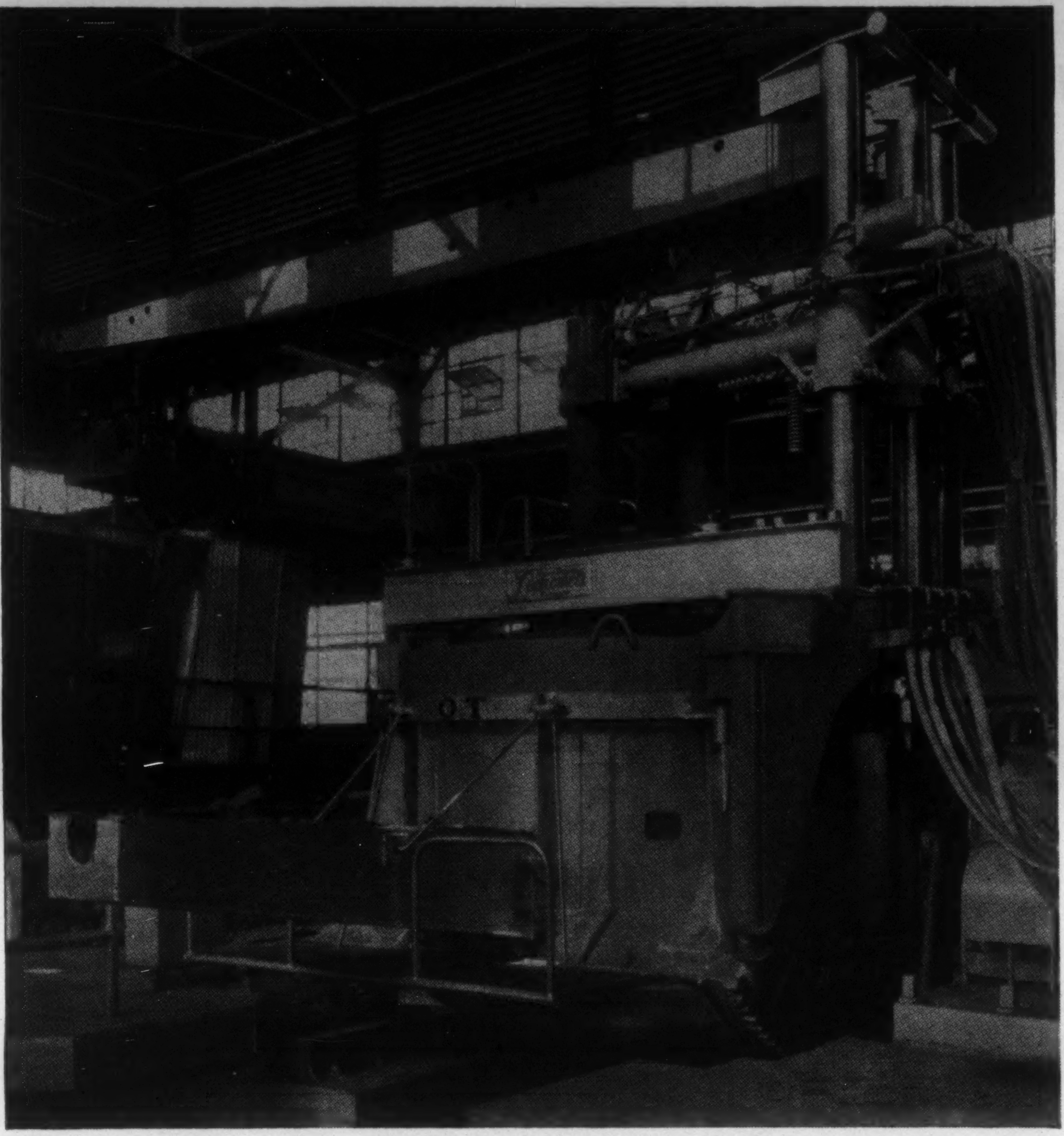
ALUMINUM ALLOYS AND MILL PRODUCTS

IF YOU SEE RUST... YOU KNOW IT'S NOT ALUMINUM

REYNOLDS METALS

REYNOLDS *Lifetime* ALUMINUM

THE COMPLETE ALUMINUM SERVICE FROM BASE METAL TO FINISHED PARTS



A good roof is of prime importance to good furnace performance. Lectromelt gives you the best.

The roof and superstructure of this Moore Rapid Lectromelt Size OT Furnace is maintained in proper alignment on the furnace body by the use of dowel pin and socket construction. These dowel pins are arranged so that the roof automatically sits down on them when it is swung back and lowered into position. The dowel pins and sockets are located both at the top of the furnace body—at the approximate level of the bezel ring—and lower down on the furnace shell, thus eliminating the necessity of hold-down clamps on the roof ring.

Lectromelt furnaces are built in capacities ranging from 250 pounds to 100 tons. Write for complete details today.

PITTSBURGH LECTROMELT FURNACE CORP.

PITTSBURGH 30, PA.

manufactured in: CANADA, Lectromelt Furnaces of Canada, Ltd., Toronto 2; ENGLAND, Birlec, Ltd., Birmingham; SWEDEN, Birlec Elektkougnar A/B, Stockholm; AUSTRALIA, Birlec Ltd., Sydney; FRANCE, Stein et Roubaix, Paris; BELGIUM, S. A. Belge Stein et Roubaix, Bressoux-Liege; SPAIN, General Electrica Espanola, Bilbao; ITALY, Forni Stein, Genoa.

MOORE RAPID
Lectromelt
FURNACES

New Materials and Equipment

not more than 1% per hr. after a 30-min. warm-up period. Under normal conditions, calibration need not be made oftener than once every 4 hr.

Continuous Casting Method Produces Dense Bearing Bronze

A new patented continuous casting method is being used by the *American Smelting & Refining Co.*, to produce a bearing bronze having 83 copper, 7 lead, 7 tin and 3% zinc that meets SAE 660 specification. The material is being produced for *Ampco Metal, Inc.*, 1745 S. 38 St., Milwaukee 4, Wis.

The bearing bronze, known as Asarcon 773, is supplied in standard sizes ranging from ½ in. in dia. up to 4¼ in. in solids and 1-in. OD by ½-in. ID to 4¼-in. OD by 3¼-in. ID in hollow bars. Lengths of 104⅞ in. are standard in this material, but distributors will cut any diameter to the length required.

The bronze is said to have an extremely dense, small, even grain structure which eliminates a majority of the costly machining difficulties encountered in other methods employed to produce to this specification. It is free of porosity, dross or sand inclusions.

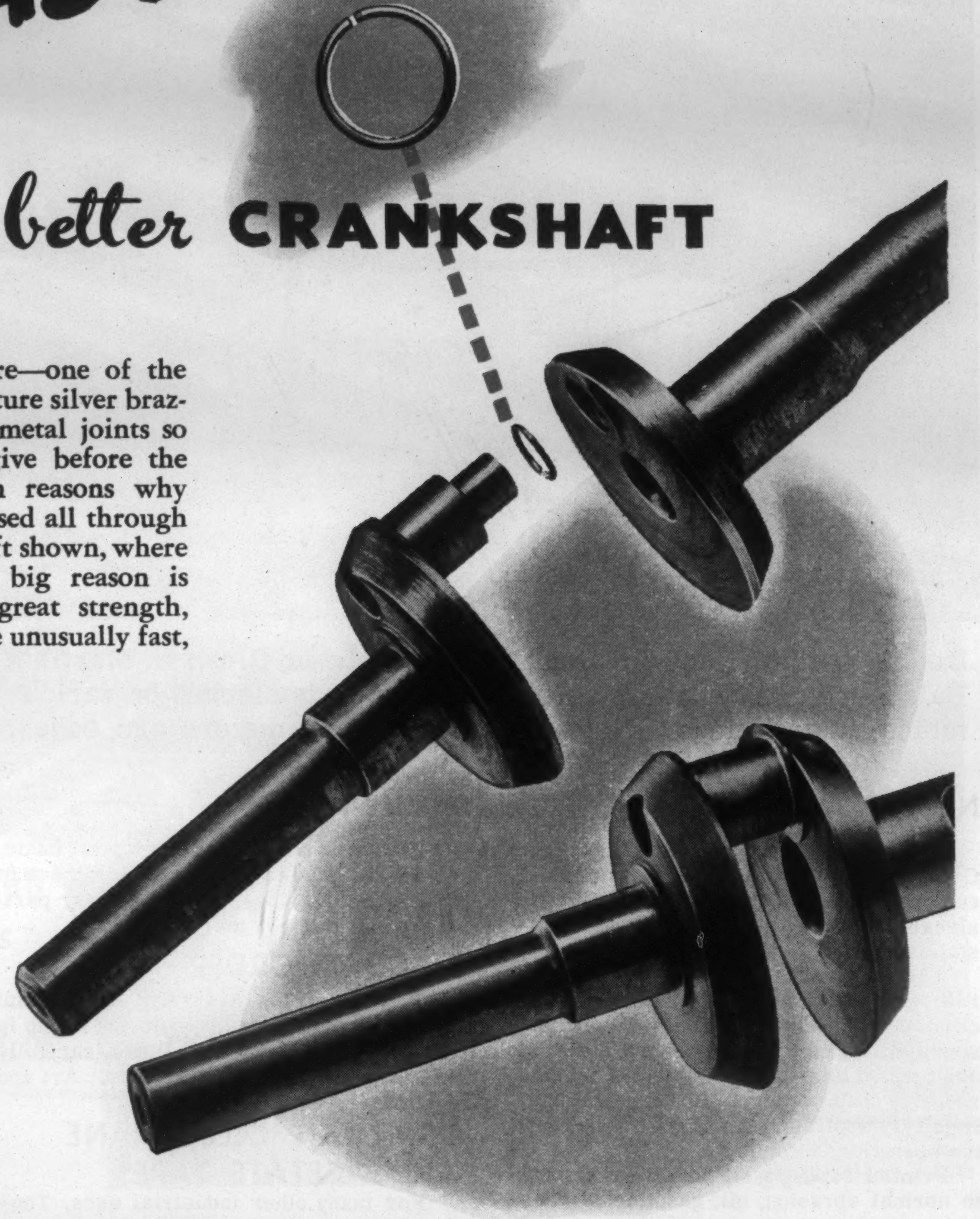
Rigidized Metal Now Available as Tubing

Rigidized Metal tubing is now available in tubing form, according to the *Rigidized Metals Corp.*, Buffalo, N. Y. Rigidized tubing is of welded carbon steel and is produced and sold by *Standard Tube Co.*, Detroit, Mich.

The textured finish of the tubing hides surface scratches and is said to be less expensive to plate because it does not require polishing. Stronger than plain metal sheet, it resists marring during fabrication and makes possible the use of lighter metal gages, thereby effecting further cost savings.

Rigidized Metal patterns produce a tubing which is more attractive in appearance than plain metal, and one which provides a longer service life, free from scratches and other evidence of wear.

THIS LITTLE EASY-FLO RING



makes a better CRANKSHAFT

It's a ring of EASY-FLO 45 wire—one of the EASY-FLO family of low-temperature silver brazing alloys—the alloys that make metal joints so strong, the parent metals will give before the joints. That's one of the main reasons why EASY-FLO brazing is so widely used all through industry on jobs like the crankshaft shown, where strength is a "must". Another big reason is that, in addition to providing great strength, EASY-FLO brazing makes possible unusually fast, low-cost production.

This small gas engine crankshaft was formerly machined from a single forging. NOW two simplified parts are assembled with an EASY-FLO 45 wire ring preplaced at the joint and brazed by induction heat in 25 seconds. The manufacturer, Erie Engine Mfg. Co., Erie, Pa. says it's *better* than the forged shaft—and *costs* less to make.

CAN EASY-FLO BETTER *Your* PRODUCTS AND CUT COSTS?

SIL-FOS
EASY-FLO

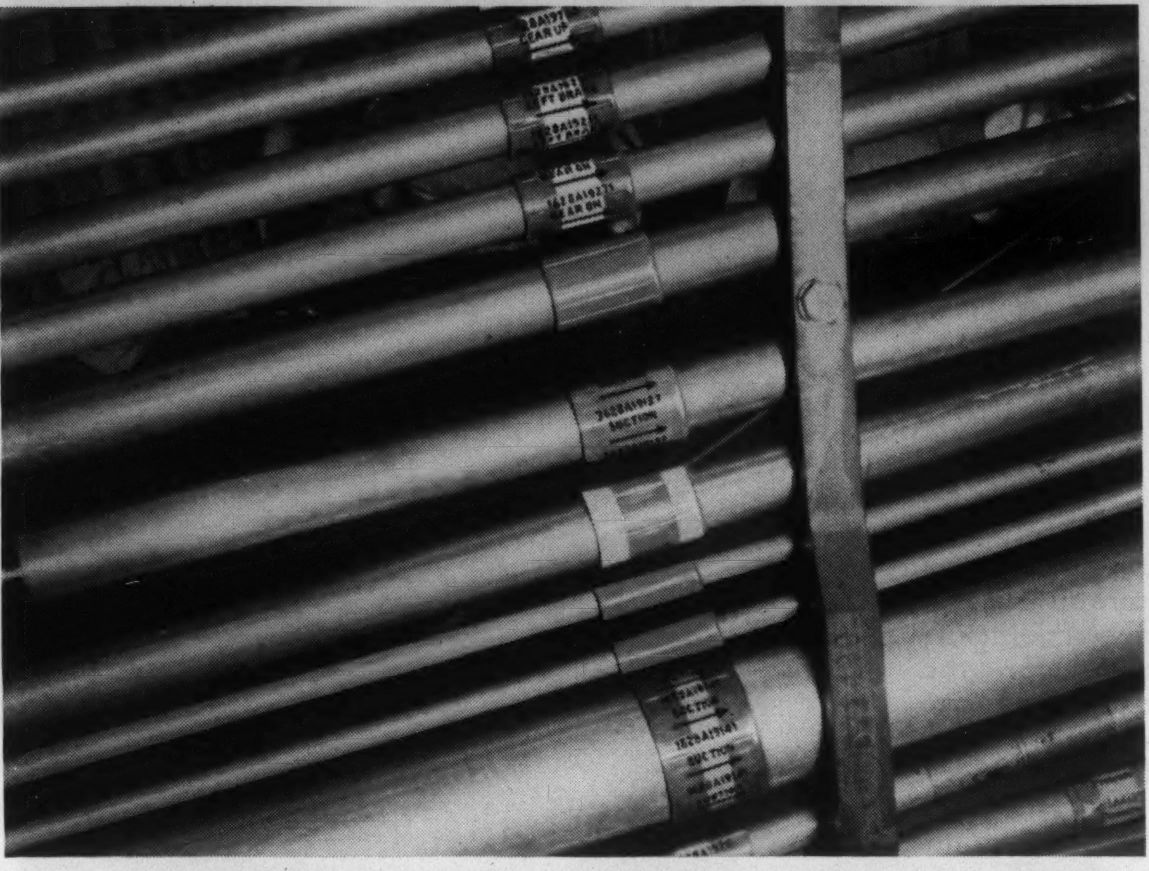
The experience of thousands of manufacturers says that it can. Why not find out—especially when it's so easy to get the answer. Just ask to have a field engineer call—and we'll send one promptly with no obligation to you. **BULLETINS 12-A and 15** will give you basic facts about EASY-FLO and its uses. Write for copies today.

HANDY & HARMAN

HANDY & HARMAN FOUNDED 1867 QUALITY SERVICE

82 FULTON STREET NEW YORK 7, N. Y.
Bridgeport, Conn. • Chicago, Ill. • Los Angeles, Cal. • Providence, R. I. • Toronto, Canada
Agents in Principal Cities

PLASTIC IDENTIFICATION SLEEVE IS NEW TOPFLIGHT PRODUCT



Detail to fluid lines in airplane assembly in Glenn L. Martin's Baltimore plant shows plastic A-N color code sleeves on various tubing installations. Note various tube diameters and codes.

NEW PLASTIC SLEEVES

The newest addition to Topflight Tape Company's printed industrial marking and coding line is a permanent type plastic sleeve adaptible to tubing and wiring installations of all kinds.

The material is cellulose acetate butyrate extruded in colors and combinations of colors, then hot stamped with printing specified. Printed lengths are then cut and formed to required diameters and are ready to snap in place. Bonding material is quickly applied to the slight overlap and the operation is complete.

Printed Topflight sleeves are resistant to normal abrasion, oil, gasoline, alcohol and will stay in place, and the printing remain legible indefinitely.

Many new uses for this product are being discovered, and Topflight specialists are available for aid in developing them.

WARNING LABELS

Caution notices, instructions on lubrication, about installation, first operation, capacities, voltage - quick and surely placed where operator must see.

TOPFLIGHT KNOWHOW

The precision tape printing machines used to process Topflight Tape are made by Topflight Tool Corporation. Topflight machines are also used by leading tape printers in foreign countries including England and Canada.

NAME PLATES

Placed in an instant, no water, paste, or wasted labels. Lustrous cellophane in two or more colors. Identify every part, every unit that you merchandise.

MADE TO ORDER

Trade marks, drawings, blue print specifications, special write or stamp in labels for amps, volts, H. P. etc. carefully executed for your requirements. Art and engineering staffs available.

TOPFLIGHT CELLOPHANE AND ACETATE TAPES

For many other industrial uses, Topflight pressure-sensitive (self-adhesive) tapes are becoming increasingly popular. Easily applied and adaptable to any industry, special marking and labelling tape speeds assembly of hundreds of products.

Topflight Tape is a product of the makers of
—TOPFLIGHT—
BROKEN DRILL CHUCKS
SPIN DIMPLERS - FIVE STAR DIMPLERS
PRESSURE PAD DIMPLERS
ROUND CORNER RIVETERS
and other Production Tools

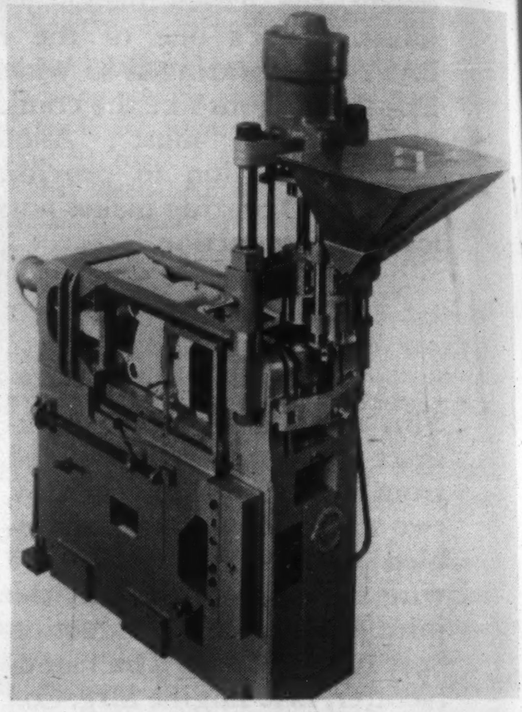
TOPFLIGHT TAPE COMPANY
Division of
TOPFLIGHT TOOL COMPANY, INC.
YORK, PENNSYLVANIA, U. S. A.

New Materials and Equipment

Injection Molding Machine for Plastics

An injection molding machine for plastics having a 4-oz. capacity is now being produced by *Lester-Phoenix, Inc.*, Cleveland 13. Maximum shots per hour on this machine is 500.

The molding machine is of solid frame construction. It uses external resistance type heaters with three pyrometers heat control instruments. Some of the important specifications of this equipment are given below.



This injection molding machine is suited to high-speed production of plastic parts.

Cu. in. molded per shot	6½
Oz. molded per shot	4
Pounds of plasticized material per hr. (dependent on products and mold construction)	60
Maximum shots per hr.	500
Diameter of injection plunger, in.	1⅞
Diameter oil plunger cylinder, in.	8¼
Pressure psi. on material at end of plunger, in lb.	19,300
Total pressure on injection plunger, lb.	53,500
Stroke of injection plunger, in.	6⅝
Time required to complete entire injection stroke, sec.	2.5
Size of die plates, in.	13 by 18
Mold closing pressure, tons	125
Capacity of feed hopper, lb.	40
Power consumption of heating units when plasticizing to full capacity per hr., kw.	7.9

Everything IN CARBON *but Diamonds!*

PLUS GRAPHITE, MOLDED METALS SINTERED ALNICO II

HUNDREDS of STANDARD ITEMS . . . *thousands of "Specials"*

Write for details on any type

Anodes • Battery Carbons
Bearing Materials
Brazing Furnace Boats
Brushes of all types for rotating electrical equipment
Carbon and Graphite Contacts
Chemical Carbons • Clutch Rings
Dash Pot Plungers
Electric Furnace Heating Elements
Electrolytic Anodes • Friction Segments
Glass Molds • Ground Rods (carbon)
Mercury Arc Rectifier Anodes
Metal-Graphite Contacts
Power Tube Anodes
Rail Bonding Molds
Rare Metal Contacts
Resistance Welding and Brazing Tips
Seal Rings (for gas or liquid)
Special Molds and Dies
Spectrographite No. 1
Trolley and Pantograph Shoes
Voltage Regulator Discs
Water Heater and Pasteurization Electrodes
Welding Carbons
Welding Plates and Paste

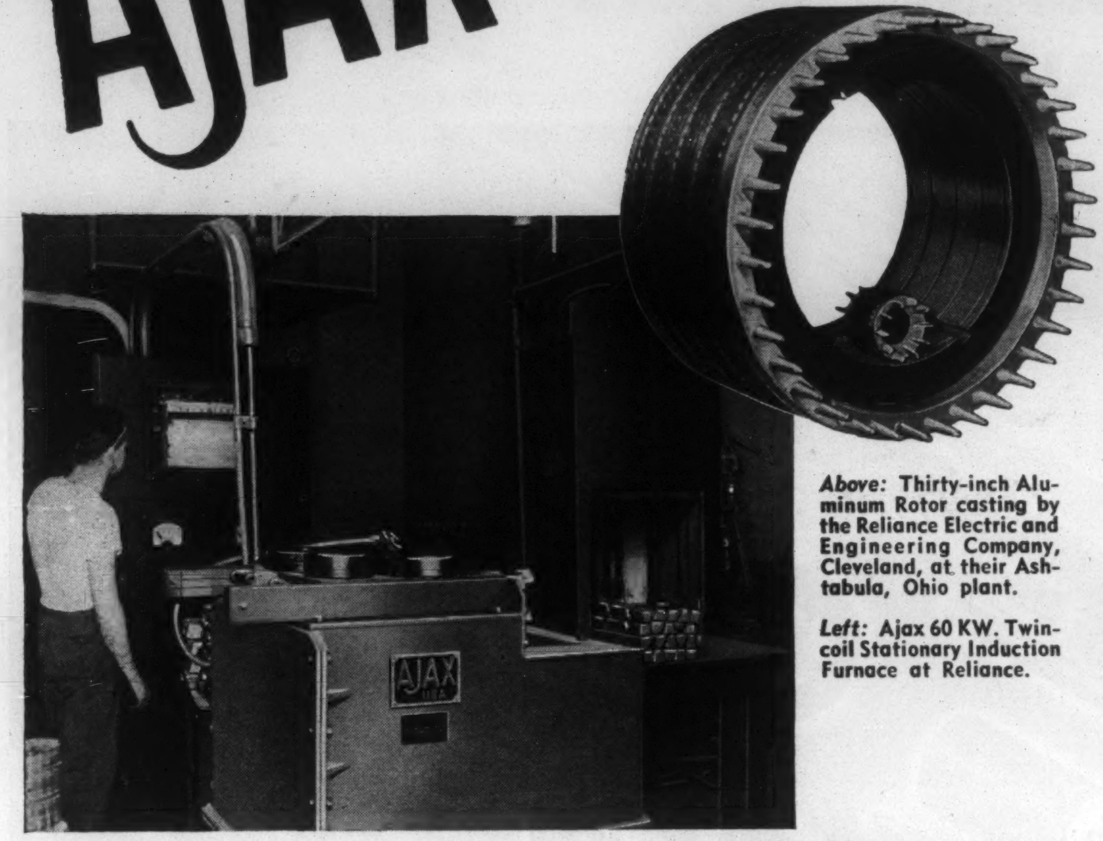
. . a dependable source of supply

The unique electrical, mechanical, physical and chemical properties of Stackpole carbon, graphite and carbon-graphite products solve countless problems of friction, temperature, arcing, corrosion, shaft sealing, voltage regulating and others. So broad is the line of standard Stackpole products, so extensive the facilities for "specials" that it is practical to list only a few of them here. Let Stackpole engineers recommend and quote on your next requirements.

STACKPOLE

STACKPOLE CARBON CO., ST MARYS, PA.

AJAX SOLVES THE PROBLEM!



Above: Thirty-inch Aluminum Rotor casting by the Reliance Electric and Engineering Company, Cleveland, at their Ashtabula, Ohio plant.

Left: Ajax 60 KW. Twin-coil Stationary Induction Furnace at Reliance.

AJAX ELECTRIC INDUCTION FURNACE HELPS INCREASE ALUMINUM ROTOR CASTING EFFICIENCY

The Ajax-Tama-Wyatt Induction Furnace at the Reliance plant plays a major part in their successful large scale production of Aluminum Rotor Castings.

The Ajax-Tama-Wyatt Electric Induction Furnace used for melting the metal preparatory to casting, is lined with a special composition to avoid contamination of high purity aluminum with silicon or iron. Temperature control of the molten metal to within one percent or less is another advantage of this furnace.

From 30 to 40 percent less floor space is required for the Ajax-Tama-Wyatt Electric Induction Furnace than is required for any other. There are no fumes—shops are cooler. Operation is almost silent—working conditions are better. You'll have better labor relations, and more efficient operation through greater shop comfort when you install Ajax Induction Furnaces. Available in a wide range up to 1,000 KW., 20,000 pound capacity.

Ajax Engineers have been the pioneers in Induction Furnaces for all metals since 1917. For technical details and full information contact:

AJAX ENGINEERING CORPORATION
TRENTON 7, N. J.

AJAX TAMA-WYATT INDUCTION MELTING FURNACE

Associate Companies: AJAX METAL COMPANY, Non-Ferrous Ingot Metals and Alloys for Foundry Use
AJAX ELECTROTHERMIC CORP., Ajax-Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax-Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax-Wyatt Induction Furnaces for Melting

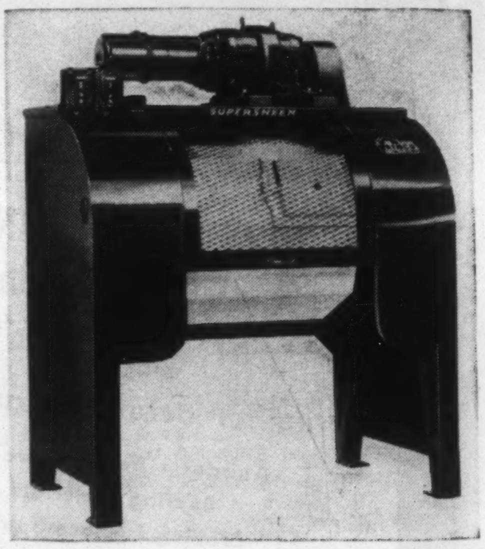
New Materials and Equipment

New Model Deburring Barrel Is Easy to Operate

A new deburring and finishing barrel, Model DB-200, that offers versatility, safety, and ease of operation is now being manufactured by the *Almco Div., Queen Stove Works, Inc.,* Albert Lea, Minn.

Barrel speed is variable at a rate of from 6 to 30 rpm., which provides the exact rate for each specific job. Safety is assured with a rollaway perforated hood, which permits positioning of barrel with the hood down. There are no protruding parts or door handles. The barrel itself is light-colored, which allows the operator better working vision.

Ease of operation is assured with a positive magnetic brake that allows inching the barrel into position. Doors are cam-operated for quicker opening and quicker closing. Two safety switches are provided—forward and reversing. This new model is available with Neoprene lining, or unlined.



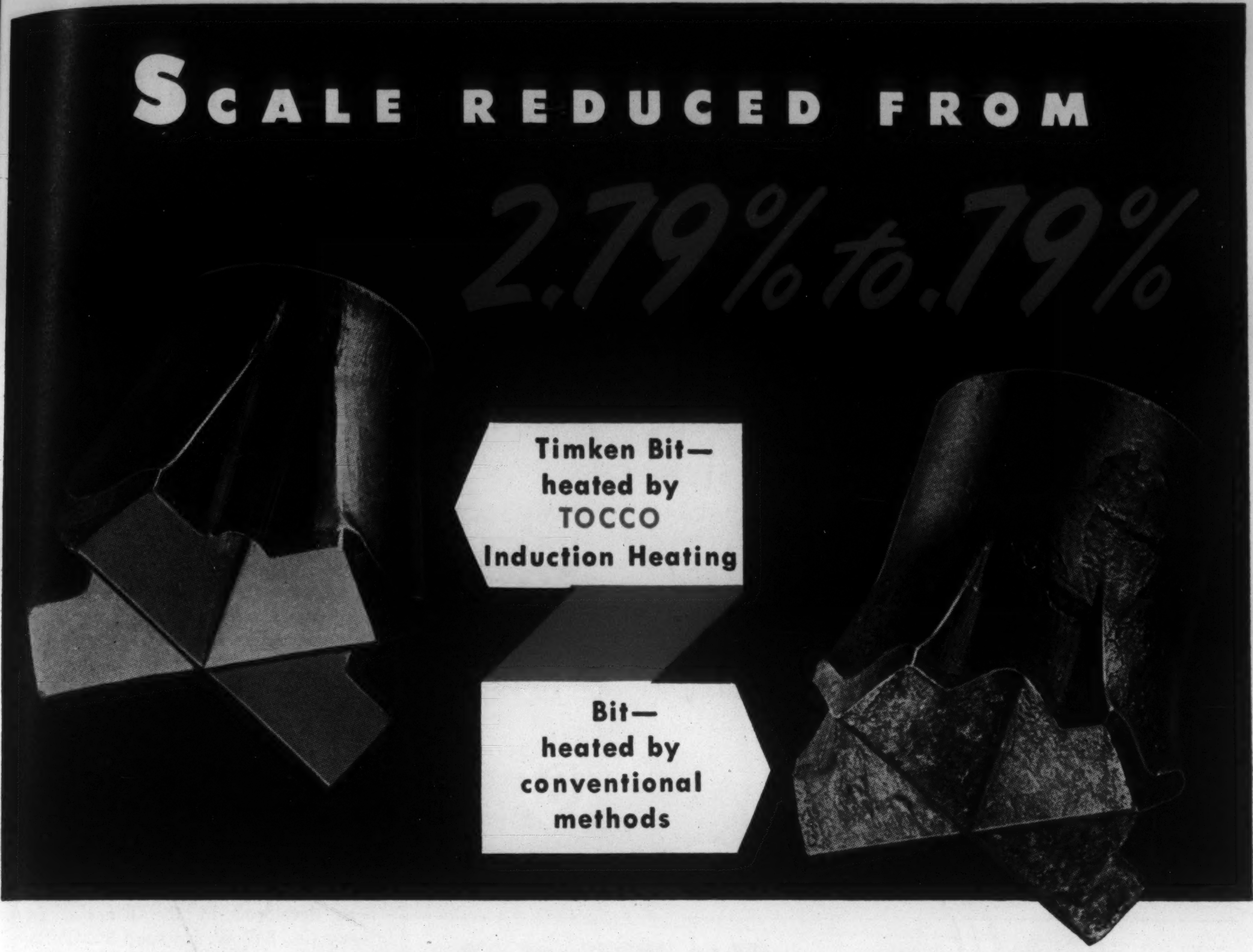
This deburring and finishing barrel features maximum safety and ease of operation.

Improved Heat-Resistant Acrylic Molding Powder

A new acrylic resin molding powder with improved molding properties and better color is available from the *E. I. du Pont de Nemours & Co.,* Wilmington, Del. This product, Lucite HM-140, replaces Lucite HM-122. The new composition enables

(Continued on page 120)

SCALE REDUCED FROM 2.79% to .79%



with TOCCO* Induction Heating

The very important savings obtained by TOCCO Induction Heating of rock drill bits for forging is typical of over a thousand cases involving metal parts of all shapes and sizes. If you manufacture parts which require hardening, annealing, brazing, soldering or forging, TOCCO can probably save you money, too.

1. **Lack of Scale.** Engineers at The Timken Roller Bearing Company report a reduction of scale—from 2.79% to .79% by the application of TOCCO to heating barstock for forging their rock drill bits.
2. **Longer Die Life.** An equally important savings results from greatly increased die life made possible by lack of scale and complete uniformity of heating obtained by TOCCO.
3. **Production Up.** Automatic TOCCO heats barstock at a rate which produces 1500 pieces per hour.
4. **Other Advantages.** TOCCO is compact, saves floor space; is free from radiant heat and gases usually present with conventional type furnaces. TOCCO engineers are glad to study your operations, without obligation, of course, for similar cost-cutting possibilities.

THE OHIO CRANKSHAFT COMPANY

JUST PUSH A BUTTON

TOCCO

*Trade Mark Reg. U. S. Pat. Off.

Mail Coupon Today

NEW **FREE** BULLETIN

THE OHIO CRANKSHAFT CO.
Dept T-5, Cleveland 1, Ohio

Please send copy of "Typical Results of TOCCO Induction Heating for Forming and Forging."

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METSO GRANULAR
~•~
The Choice

VOTE

☑ **FAST ALUMINUM CLEANING**

Leading aluminum processors use Metso Granular because it degreases quickly. In some instances, immersion time is as short as 2½ seconds. Besides that, most aluminum must not be harmed, and here, Metso's unique controlling component, soluble silica, prevents strong etching of the sensitive metal.

Where parts must be given longer exposures, at very high concentrations in the cleaning baths, Metso Granular cleaner is further buffered with our "G" Silicate. Send us your inquiries on cleaning aluminum. Full information on Metso Cleaners and PQ Soluble Silicates on request.

PHILADELPHIA QUARTZ COMPANY
1133 Public Ledger Bldg., Philadelphia 6, Pa.

PQ SILICATES FOR FABRICATING METAL CLEANERS

Metso Granular
($Na_2SiO_3.5H_2O$) Sodium Metasilicate. Free-flowing, white granular product.

Metso 99
($Na_3HSiO_4.5H_2O$) Sodium Sesquisilicate. White, granular, free-flowing.

G-C Brand
($Na_2O.2SiO_2$) Powdered Sodium Silicate. Hydrated, alkaline. Readily soluble.

G Silicate
($Na_2O.3.22SiO_2$) Hydrated powdered sodium silicate (sometimes referred to as trisilicate), rapidly soluble.

METSO PQ

Sodium Sesquisilicate U. S. Pat. 1948730, 2145749 • Sodium Metasilicate U. S. Pat. 1898707

Short cut to success with Molded Plastics

CALL A WATERTOWN MAN

If you have a part or product to be molded of plastic, your nearest Watertown man will place our 34 years experience as custom molders of every type of plastic for thousands of different applications at your service.

If the job calls for development of a special molding compound, or close control of production, you profit from our laboratory . . . second to none in the industry. There we X-ray, push, pull, twist, pound and bake experimental and production samples . . . analyze their electrical, physical, chemical and mechanical properties . . . until you, and we, know the job is right.

Here are the Watertown men . . .

New York—H. A. Rankow, 175 Fifth Ave.
Chicago—National Insulations Co., 2808 W. Lake St.
G. W. Glaescher
J. P. Bonnamy
R. C. Farquhar
J. R. Kallaher
J. P. Greener
Detroit—J. P. Greener from Chicago
Cleveland—Carl F. Linn, 866 Hanna Bldg.
Milwaukee—Roger L. Miller, 729 N. Broadway
Seattle—John W. Witherow, National Vulcanized Fibre Co. 1927 First Ave., South
San Francisco—G. W. Harmssen, National Vulcanized Fibre Co. 273 Seventh Ave.
Los Angeles—Fred M. Foley, National Vulcanized Fibre Co. 2325 East Eighth St.

THE WATERTOWN MANUFACTURING CO.
600 ECHO LAKE RD., WATERTOWN, CONN.

New Materials and Equipment

molders to obtain the higher heat resistance of HM-122 with the moldability of softer acrylics. It can be injection-molded at cylinder temperatures of 360 to 490 F, about 50 F hotter than was practical with HM-122.

The new acrylic exhibits better flow at a given molding temperature; it can be molded into thick sections at lower temperatures using the same pressure, or at lower pressures using the same molding temperatures. In addition, the new composition is even more water-white than former heat-resistant acrylics, and color stability, both at higher temperatures and on outdoor exposure, has been improved.

Like other Lucite powders, it is manufactured in a wide range of transparent, translucent, and opaque colors. It costs no more than general-purpose acrylics.

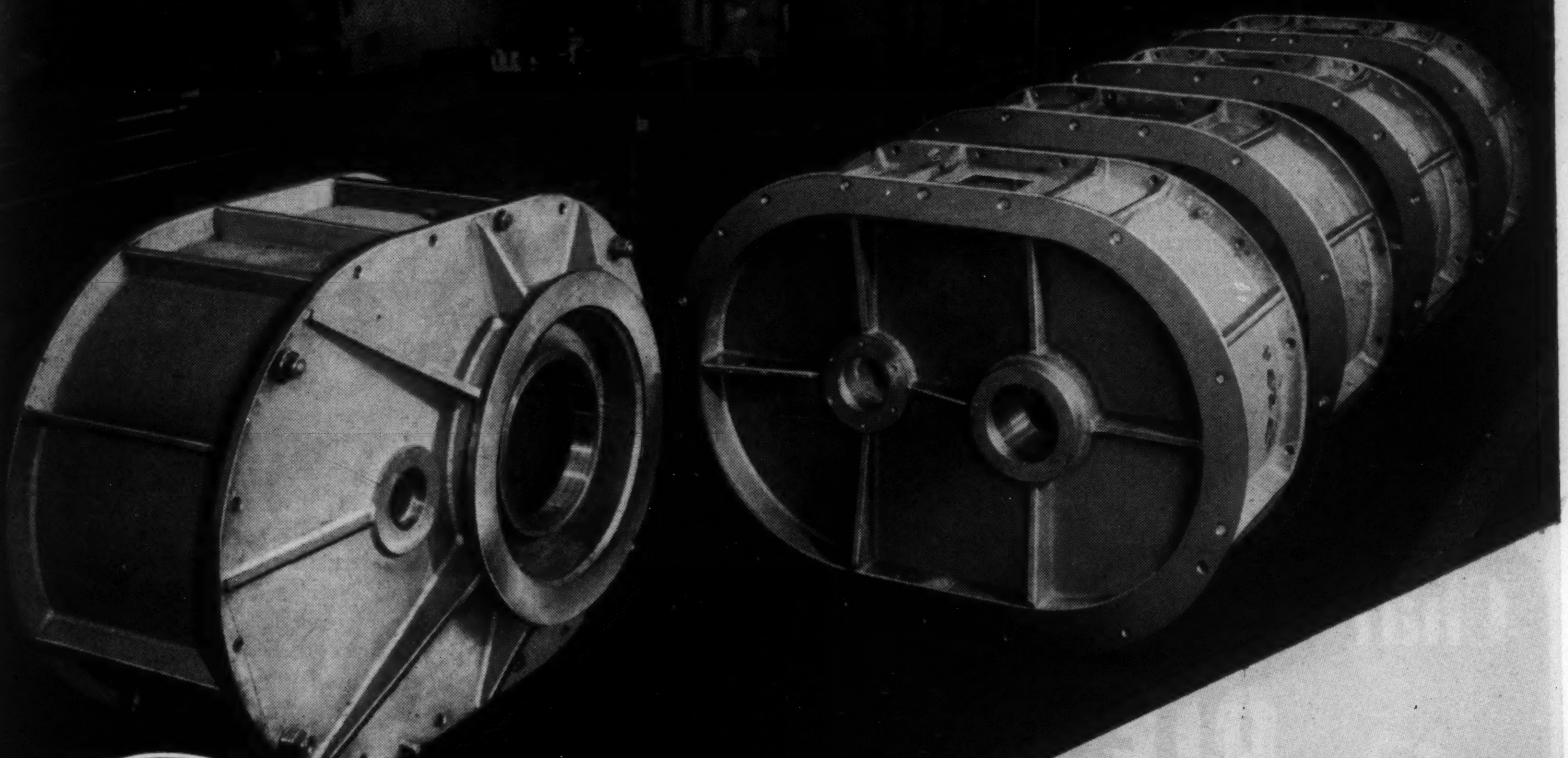
● A new type of indicating controller has been developed by the *Wheelco Instruments Co.*, 847 W. Harrison St., Chicago 7. The instrument, named Multi-Switch Capacitrol, will become a part of the company's line of controllers for the measurement and control of process variables such as temperature, voltage, amperage, pressure, speed, etc. A high resistance, fully compensated, direct reading meter movement with Alnico V Magnet is used for applications which fall in the pyrometric range. Models using resistance thermometer measuring systems are available for low temperature operation.

Water Wash Compounds Control Paint Overspray

Recently two announcements of spray booth compound have been made. A water wash compound for paint spray booths that lubricates the overspray has been announced by the *Northwest Chemical Co.*, 9301 Roselawn Ave., Detroit 4. This compound coats each particle of paint with a non-volatile solvent, and any overspray so lubricated won't stick to the back curtain or any of the eliminators. The booth keeps clean and the sludge remains floating for easy skimming. An advantage is the elimination of down-time for booth cleaning and baffle stripping.

The *DuBois Co.*, Cincinnati 3, Ohio has also developed a non-foaming water wash spray booth compound. Because of its non-

Steel-Weld FABRICATION



Here is more evidence of fine workmanship in both the production and machining of Steel-Weld Fabricated parts of heavy machinery assemblies. This is the quality of workmanship YOU can expect from the Mahon organization . . . because, Mahon offers a unique source for welded steel in any form, regardless of size, weight, or shape . . . a source with complete facilities for producing, magnetic inspection, stress analyzing, normalizing, grit blasting, machining and spray painting. These facilities manned by highly skilled craftsmen under the supervision of a staff of design engineering experts, are your assurance of a better, smoother appearing job, embodying every advantage of Steel-Weld Fabrication.

THE R. C. MAHON COMPANY
DETROIT 11, MICHIGAN

Engineers and Fabricators of Welded Steel Machine Bases and Frames, and Many Other Welded Steel Products

MAHON

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GAS-FIRED
OIL-FIRED
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FURNACES
for

- AGING
- ANNEALING
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- CARBON RESTORATION
- CARBURIZING
- CERAMIC DECORATING
- DRAWING
- HARDENING
- HOMOGENIZING
- MALLEABLIZING
- NORMALIZING
- NITRIDING
- SINTERING
- SOLUTION TREATING
- SPECIAL ATMOSPHERE TREATMENTS

A SIZE AND TYPE
OF FURNACE
FOR EVERY
PROCESS
PRODUCT OR
PRODUCTION

SCALE-FREE ANNEALING NICKEL-SILVER AND ALLOY WIRE

● The installation view above shows another interesting EF gas-fired recuperative radiant tube special atmosphere continuous roller hearth furnace. This equipment clean and scale-free anneals nickel-silver and other alloy wire in coils—handles 700 lbs. of wire per hour in coils up to 30" in dia.

EF furnaces are built in different types, for performing a wide variety of heat treating processes. Gas-fired, oil-fired, or electrically heated, whichever is best for your particular problem,—and location. Let us work with *you* on *your* next furnace problem.

THE ELECTRIC FURNACE CO.
GAS FIRED, OIL FIRED
AND ELECTRIC FURNACES
Salem - Ohio

Char-Lynn ALUMINUM
DIE CASTINGS

By a special Char-Lynn process, heavy section castings can be produced without porosity. Fast, accurate Reed-Prentice machines, manned by able craftsmen, turn out castings of quality. You are assured of permanence of dimension and shape . . . good surface finish . . . time and money saved in your finishing department. *Write or phone for engineering consultation and estimates.*

LARGEST IN THE UPPER MIDWEST . . .

Up to 6 pound capacity

CHAR-LYNN COMPANY
2875 26th AVENUE SOUTH • MINNEAPOLIS 6, MINN. • DUpont 2354

New Materials and Equipment

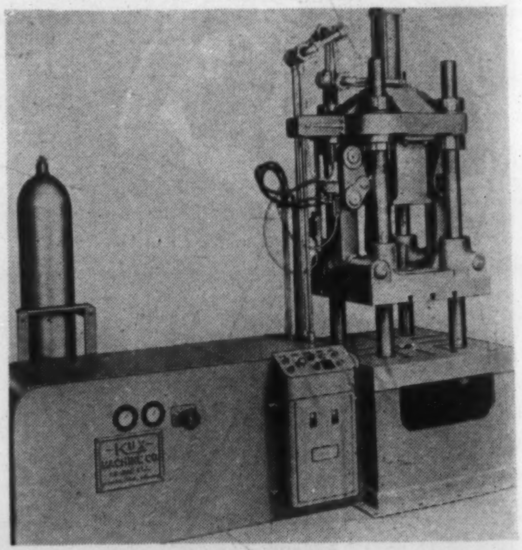
foaming characteristics, higher concentrations can be used which, in turn, keeps the hydraulic system of the spray booth clean. This material is recommended for use in the newer down-draft booths where even the slightest amount of foam is objectionable.

Die Casting Machine Designed for Production of Parts with Inserts

The latest cold chamber die casting machine of vertical-type construction to be offered by the *Kux Machine Co.,* Chicago, is designed specifically to be of special usefulness in the production of parts that have inserts cast in.

The machine has its die plates mounted in a horizontal position while its die plates operate in a vertical direction. Thus, castings with inserts can be placed in the lower die half without difficulty, and the inserts remain in place all through the die casting cycle without falling out of their cavity placement.

Castings such as electric motor rotors, flywheel and magneto parts having magnet inserts, and parts with bushings cast in can now easily be made on this new machine whose verticle design eliminates the necessity for costly die construction to keep inserts in place.



Castings with bushings cast in can be easily made on this new die casting machine.

Completely hydraulically operated and electrically controlled, the machine has a self-contained hydraulic operating mechanism, and an injection pressure multiplier available for increasing injection pressure. The machine, Model HP-22, will produce castings weighing up to 4½ in. square between the bars.

WHEN THERE'S HARD WORK AHEAD FOR STEEL PARTS ... use *Republic* Cold Drawn Alloy Steel Bars

When steel parts must carry heavy loads—or withstand severe shock and strain—or resist abrasion resulting from high speed or continuous use—you probably can keep equipment in use longer and *cut maintenance and replacement costs* by using Republic Cold Drawn Alloy Steel Bars.

Republic Alloy Steels are exceptionally high in strength and toughness. They respond uniformly to hardening treatment. In cold drawn bar form, they provide the close tolerance, accuracy of section, fine surface finish and UNIFORM MACHINABILITY characteristic of Union Cold Drawn Products. Thus, they further add to economy by helping to cut parts production costs.

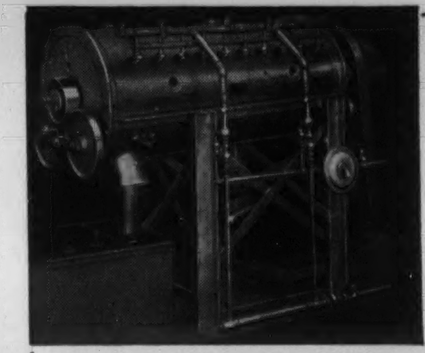
Republic Cold Drawn Alloy Steel Bars are available in all popular analyses, in standard shapes and sizes, furnace treated as you require—annealed, normalized, heat treated, spheroidized, stress relieved or carbon corrected.

Republic metallurgists are ready *now* to help you get the results you need. Write for further information.

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York

Republic COLD DRAWN
REPUBLIC STEEL
REG. U. S. PAT. OFF.
ALLOY STEEL BARS

Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Plates, Pipe, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing



CONTINUOUS ROTARY HEATING FURNACES

SUITED TO WIDE VARIETY OF PROCESSES AND PRODUCTS

ADAPTABLE to many types of operations, A.G.F. Continuous Rotary Heating Furnaces are used for clean hardening, annealing, normalizing, carburizing, case hardening by the patented Ni-Carb process, and other types of general and atmosphere work.

WORK HEAT TREATED in these furnaces ranges from small pins and bearing parts up to heavy forgings for universal joints, which are normalized in the larger rotaries. These furnaces also find application in the process industries for calcining carbonates and nitrates, burning garnet grain, and similar processes.

UNIFORM HEATING is assured by the gentle mixing of the work as it passes through the rotating retort. The speed of rotation is controlled by a stepless variable transmission, permitting quick and exact adjustment of the time-temperature cycle.

ATMOSPHERE CONTROL is complete and positive. The atmosphere gas is introduced through a simply-designed, trouble-free connection.

LONG LIFE of the alloy retort is assured by the fact that it remains within the heat at all times. Only the work enters and leaves the furnace.

ECONOMICAL OPERATION is secured by the thick lining of insulating refractory, backed by block insulation. Firing by means of many small burners keeps fuel efficiency high, heat losses low.

AMERICAN GAS FURNACE CO.
142 SPRING ST., ELIZABETH, N. J.

A 21-TON CASTING
COULD BE A WHITE ELEPHANT

It takes considerable gumption to design a 20-ft. grinder bed. Many things could go wrong in casting such a monster. But the designer of this bed had confidence in our ability to cast it without distortion and structural defects—and that's what we did.

In many instances, ADVANCE CASTINGS are shipped considerable distances because our customers have found that it pays to go far for dependable foundry work. The cost of transportation—in fact, the entire cost of a casting—is insignificant compared to the extra machining costs which would be incurred in working up a casting that developed blow-holes, hard spots, sponginess, etc.

The character of our castings became widely known through *Strenes Metal* cast dies. We employ the same techniques in custom foundry work. If you want the evidence, write or phone us.

ADVANCE CASTINGS
THE ADVANCE FOUNDRY CO.
DAYTON 3, OHIO

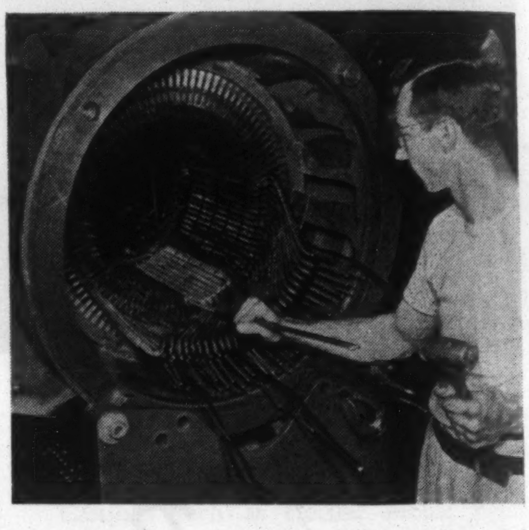
STRENES METAL • ALLOY GRAY IRON • GRAY IRON

New Materials and Equipment

Flame-Resistant Electrical Laminate for Heavy-Duty Insulating Applications

A new series of heavy-duty Fiberglas-reinforced electrical insulating laminates said to have all the requirements of high-impact class B insulating plate materials, plus flame resistance, has been announced by *Laminated Plastics, Inc.*, 14838 Euclid Ave., Cleveland 12.

These new materials possess a combination of high rigidity, impact strength, arc and flame resistance, heat resistance, and low moisture absorption. It is reported that they are being used in heavy-duty apparatus by several leading manufacturers of electrical power equipment. These plate materials, designated Glastic, are available in standard thicknesses from 1/32 to 1½ in. and in standard sheets 36 by 48 in.



A mill motor, showing a Glastic slot stick assembly.

New Chlorinated Hydrocarbons Developed for Many Uses

Development of a series of new chlorinated hydrocarbons has been announced today by the *Pennsylvania Salt Manufacturing Co.*, 1000 Widener Bldg., Philadelphia 7, Pa. The first of the series is a clear, viscous resinoid, with good thermal stability and showing no hydrolysis during 16-hr. contact with water at room temperature and at 212 F. The product is known as Chlorinated Hydrocarbon-70.

The compound has no flash point and no fire point, and is compatible with such resins as vinyl chloride, styrene and rosin. At room temperature it is completely soluble in most alcohols, ketones and hydro-

IT STILL TAKES ACORNS . . .

TO PRODUCE MORE MIGHTY OAKS OF AMERICAN INDUSTRY

In the past 45 years Doehler-Jarvis has grown from acorn size to the largest company in the die casting industry.

We know from experience all the difficulties on the road to the top. And we fully realize that this process of industrial growth, from acorn to oak, must continue if we and all enterprise are to prosper.

Therefore, we at Doehler-Jarvis are constantly on the lookout for little "acorn" companies which need help to grow. We can be of great assistance to them with our die casting process to eliminate heavy investments and, at the same time, reduce costs by converting from more complex and expensive methods.

Having already helped many of our smaller customers prosper and grow, we are anxious to help others the same way.

No matter how small your operations, our engineers, technicians and experienced business executives will be glad to discuss your production problems with you.

DOEHLER-JARVIS CORPORATION

The World's Largest Producer and Finisher of Die Castings

Executive Office: 386 FOURTH AVENUE · NEW YORK 16, N. Y.

HYDRIDES
CALCIUM HYDRIDE
TITANIUM HYDRIDE
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●

METALLURGICAL ALLOYS
TITANIUM-COPPER
TITANIUM-NICKEL
ZIRCONIUM-COBALT
ZIRCONIUM-MAGNESIUM
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METAL HYDRIDES INC.
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7 points for better melting
OF FERROUS, NON-FERROUS OR PRECIOUS METALS
WITH AJAX-NORTHRUP FURNACES

- Push-button control. The new Ajax-Northrup converter is self-tuning, does not require any adjustments while melting
- Negligible maintenance, limited to annual inspection of two electrodes
- Efficient, low-cost melting, with trouble-free performance
- Extended crucible life
- Reproduces the same analysis melt after melt—even with tough-to-handle alloys
- Easy, quick changeover from one alloy to another makes it the ideal tool for small foundries, precision casting, and research
- High Speed—20 Kw. converter melts 30 lbs. of brass in 20 minutes, or 17 lbs. of steel in 29 minutes. Built also in 3, 6 and 40 kw. sizes. Generator operated units to 8 tons

AJAX ELECTROTHERMIC CORPORATION
AJAX PARK, TRENTON 5, N. J.

Associate Companies
THE AJAX METAL COMPANY • AJAX ELECTRIC FURNACE CORPORATION
AJAX ELECTRIC COMPANY, INC. • AJAX ENGINEERING CORPORATION

SINCE 1916
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HEATING & MELTING

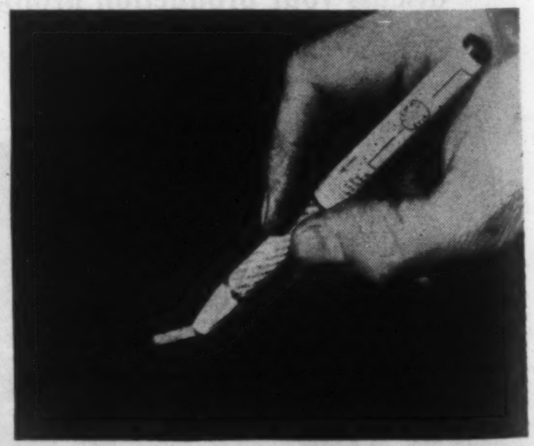
carbons. During its development the new product was subjected to a series of preliminary physiological tests. An impartial toxicological laboratory brought 200 human subjects into direct skin contact with the product for a period of five days with no adverse effects. When the same tests were repeated on the same subjects three weeks later, no induced sensitivity was evident.

To test the acute vapor toxicity, animals were exposed to concentrated vapors evolved from the heated material for a period of 8 hr. No untoward reactions were detected, according to the same laboratories.

The new chlorinated hydrocarbons have properties which suggest their use in many industrial applications. Among these are: as a plasticizer; as a flame retardant; in the manufacture of adhesives; and in other formulations for the impregnation or coating of wood products, textiles and paper.

Range of Temperature-Indicating Products Extended

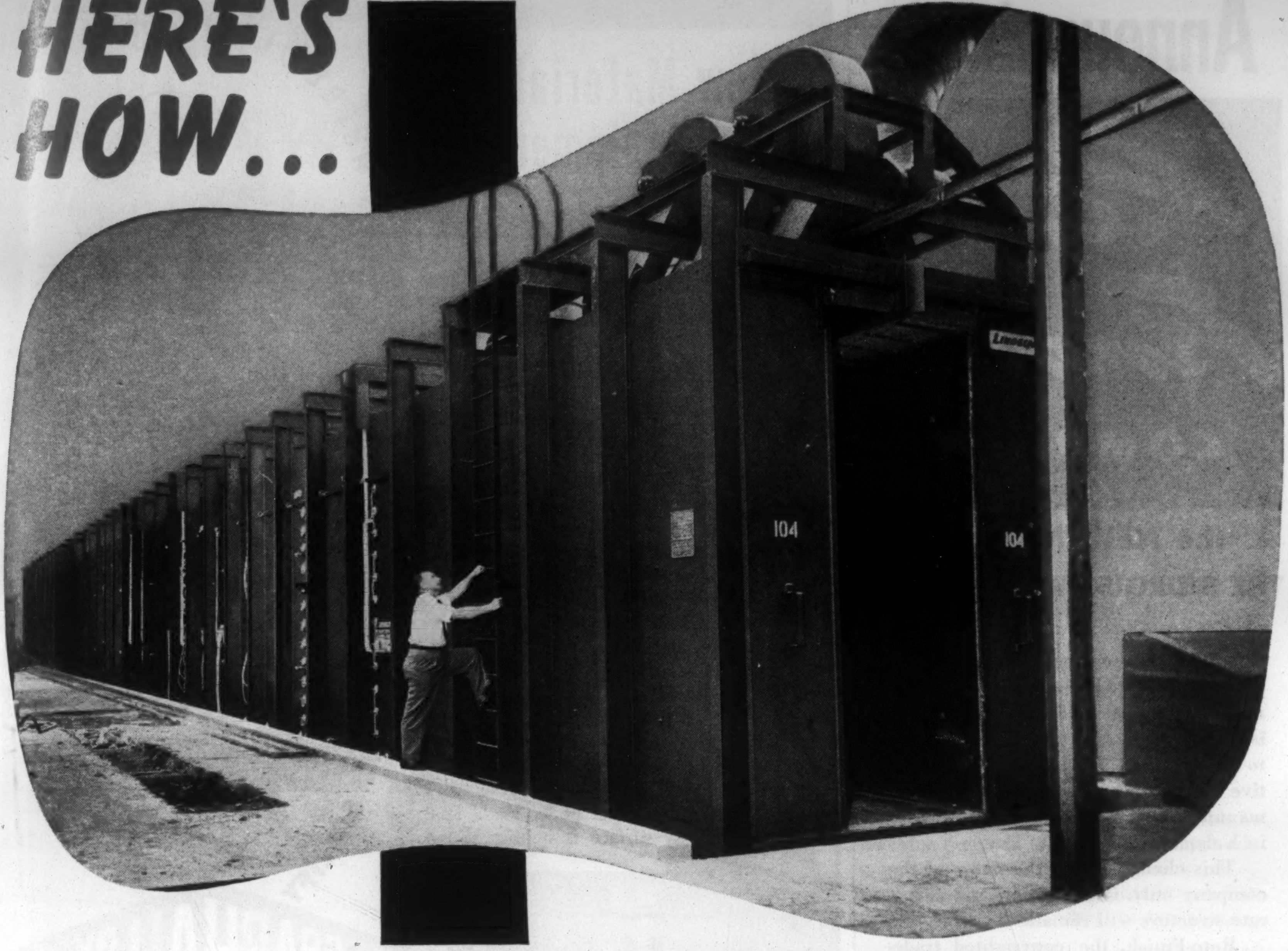
Temperature-indicating pellets and crayons for higher ranges have been added to the line of temperature-indicating products produced by the *Tempil Corp.*, 132 W. 22 St., New York 11. Both crayons and pellets can now be obtained in the temperature range between 1600 and 2000 F. This is of special interest because of the growing importance of higher operating temperatures in today's technology.

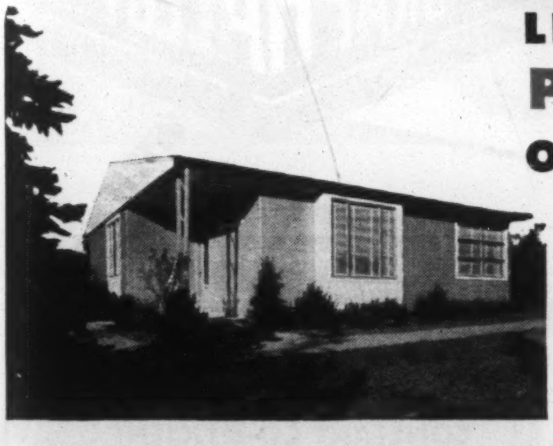


A temperature indicating crayon being drawn across a heated surface.

Beginning with 113 F, crayons and pellets are now available in 12½-degree steps to 400 F and in 50-degree steps from 400 to 2000 F. The paint form of temperature indicator is available in similar intervals from 113 to 1600 F only.

HERE'S HOW...





The new factory-built Lustron Home.

LINDBERG VITREOUS ENAMELING FURNACES PROCESS 58,000 LBS. PER HOUR OF LUSTRON HOMES

Two large electrically heated Lindberg Vitreous Enameling Furnaces process 58,000 lbs. per hour of Vitreous Enamel on steel (with tools).

These two Lindberg Furnaces, designed as an integral part of the Lustron assembly line, process an unusually wide range of architectural shapes for the new Lustron Home. These include wall sections 8′6″ x 24″, roof strips 8′6″ long, doors 6′10″ x 38″, framing of various sizes, mouldings as small as one inch in width, exterior panels and many other parts.

Each furnace is 180 feet long with a work chamber 11 feet high. Heating elements are grouped into 32 separately controlled temperature zones to allow accurate, flexible control of the temperature gradient. Traveling thermocouples periodically accompany the porcelain enamel work and assist the operator to establish and maintain the proper furnace burning conditions, and can, if necessary, provide a complete ware temperature record every 15 minutes. Other new design features of these furnaces are kinetic air plugs and electronic silhouettes.

Lindberg designs, fabricates, and installs a complete line of oil, gas, and electrically heated industrial furnaces for enameling, heat treating, and melting. Whether you need a small laboratory furnace, a standard production line model, or a large, specially designed and custom built installation, consult your local Lindberg representative . . . or write to Lindberg Engineering Company, 2454 West Hubbard Street, Chicago 12, Illinois.

LINDBERG FURNACES

Announcing–

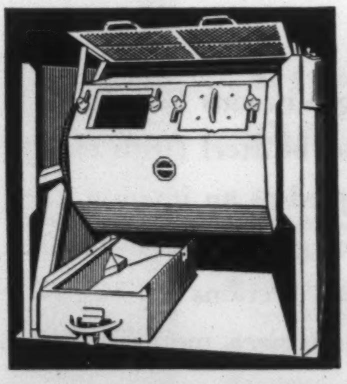
Roto-Finish
COMPANY

the *NEW NAME* of
THE STURGIS PRODUCTS CO.

The Sturgis Products Co., Sturgis, Mich., producer of Roto-Finish materials, equipment and processes for mechanical finishing, has changed its corporate name to the ROTO-FINISH COMPANY, effective July 1, and will move all sales and manufacturing activities to its new plant in Kalamazoo, Michigan.

This change affects the name of the company only. Organization and corporate structure will remain the same.

Roto-Finish, the copyrighted trademark, was incorporated in the new name because it is widely known in industry and is more descriptive of the company's operation.



Roto-Finish
Cuts Costs
Saves Time

ROTO-FINISH COMPANY
3600 Milham Road P.O. Box 855
Telephone Kalamazoo 4-9481
Kalamazoo, Michigan

ROTO FINISH
Trademark Reg. U. S. Pat. Office

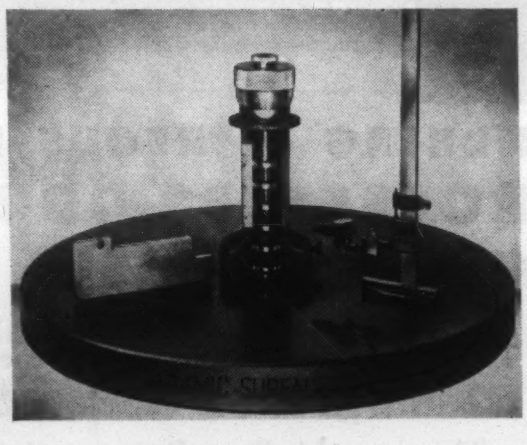
ORIGINAL ENGINEERED
MECHANICAL FINISHING PROCESSES

New Materials and Equipment

Ceramic Surface Plate Has High Wear Resistance

A new ceramic surface plate has been designed by the *Norton Co.,* Worcester 6, Mass., for use in toolrooms and inspection departments where precision setups and check measurements are required. This plate is said to provide three advantages: high wear-resistance, a precisely flat surface guaranteed to be within 0.0001 in., and a continuously smooth surface finish.

This new ceramic surface plate is made of one of the hardest substances known. Field trials conducted on this plate by the manufacturer reveal an almost complete absence of wear either to the plate itself or to gages and instruments used on it. These same field trials have shown that the plate will not warp or deform, give expansion troubles, or deflect under load. Its smooth semi-glossy surface is neither slippery nor sticky and has been proven ideal for blueing.



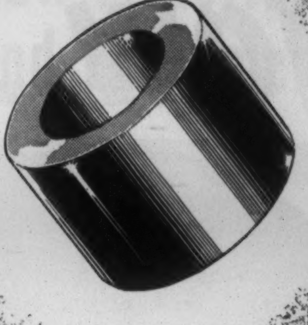
This ceramic surface plate is available in standard sizes of 5 to 24 in.

The precise flatness combined with the unusual smoothness of this ceramic surface plate shortens the time required to take readings on an indicator. Likewise, its accuracy permits exact duplication of readings.

The plate is non-magnetic. It will not sweat or corrode under any atmospheric condition, and it may be cleaned easily with soap powder and water.

● A new setting for galvanizing furnaces which is reported to increase production as much as 50% has been developed by *Furnace Engineers, Inc.,* 1551 W. Liberty Ave., Pittsburgh, Pa. The new setting is also said to cut production costs by increasing pot life and reducing fuel consumption. Because the new setting allows for minimum of fuel use during idling periods and provides for quick starting-up, over-all fuel costs are substantially lowered.

WORKS WHERE OTHERS WON'T



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BEARINGS

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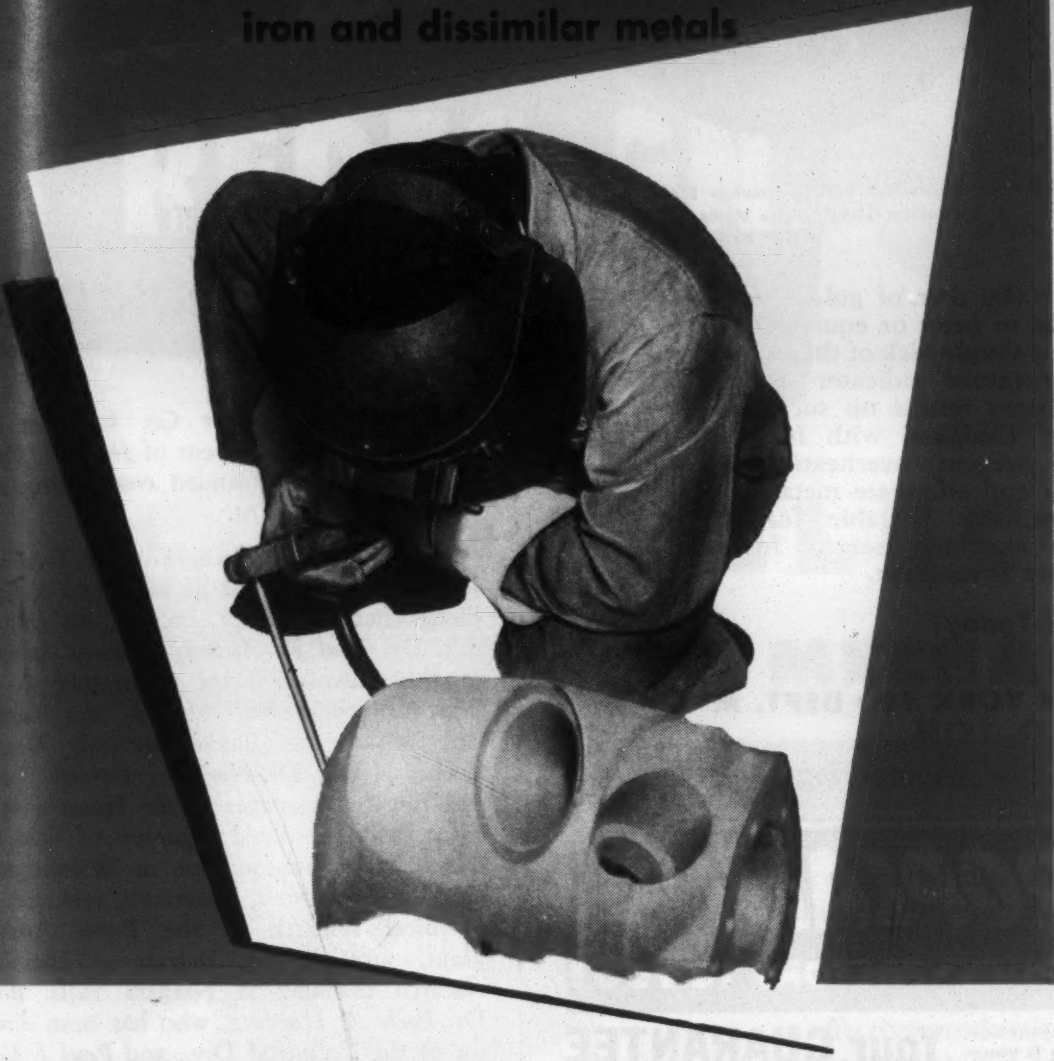
GRAPHALLOY
TRADE MARK REG. U. S. PAT. OFF.
WITH CONFIDENCE

SELF-LUBRICATING ● EXTREMELY DURABLE ● CONSTANT CO-EFFICIENT OF FRICTION ● OPERATES DRY — OR SUBMERGED IN WATER, GASOLINE OR CORROSIVE LIQUIDS ● APPLICABLE OVER A WIDE TEMPERATURE RANGE — *even where oil solidifies or carbonizes* ● EXCELLENT AS A CURRENT-CARRYING BEARING.

GRAPHITE METALLIZING
CORPORATION
1010 NEPPERHAN AVENUE, YONKERS 3, NEW YORK

For Aluminum Bronze Weld Deposits of
high strength, high ductility and good corrosion resistance
on bronzes, cast and malleable iron and dissimilar metals



Specify AIRCO NO. 100 ELECTRODE

The Airco No. 100 is a shielded arc, general-purpose, aluminum bronze electrode for flat and horizontal welding with D-C, reversed polarity.

This popular electrode is used for producing sound, clean welds having high mechanical properties on bronzes, Muntz Metal and brass . . . and also on malleable iron, clean cast iron and steel.

For welding harder grades of aluminum bronze — in the flat position with D-C, reversed polarity — Airco Nos. 116, 120, 125 and 130 Electrodes are used for their properties as non-ferrous, hard, overlay deposits — which are corrosion and acid resistant.

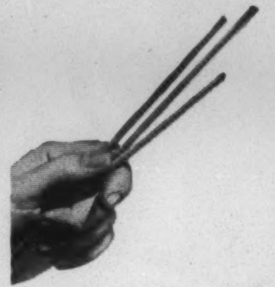
For more information on Airco No. 100, as well as Nos. 116, 120, 125 and 130 Electrodes, write your name and address on the margin below and send it to your nearest Airco office or authorized dealer for a copy of Catalog No. ADC-650A.

★ ★ ★

Air Reduction supplies Oxygen, Acetylene and other industrial gases . . . Carbide . . . and a complete line of gas cutting machines, gas welding apparatus and supplies, plus arc welders, electrodes and accessories. Ask us about anything pertaining to gas welding and cutting, and arc welding . . . we'll be glad to help you.

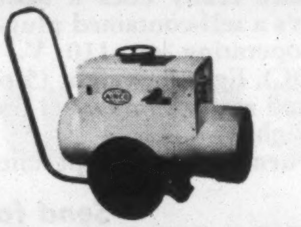
More news about AIRCO *products*

STAINLESS STEEL ELECTRODES



Over 25 different types to fit most any problem involving the welding of stainless steels. For application with D-C, reversed polarity most electrodes are furnished with a heavy extruded lime type coating. For all position A-C or D-C application all but the straight chrome analysis are obtainable with an extruded titania type coating.

HORNET 36A D-C WELDER

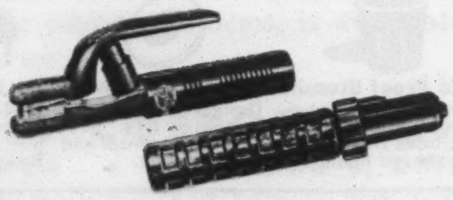


A heavy-duty, high-speed, light-weight machine designed to furnish smooth, steady current for every D-C arc welding job — even under severe operating conditions. 200, 300 and 400 ampere sizes are available.

BUMBLEBEE A-C WELDER

This machine is known for its improved electrical efficiency at rated loads, wide current range, low open circuit voltage (75 volts), vastly improved power factor, quiet operation and minimum maintenance. There is a size available for every A-C welding purpose.

ELECTRODE HOLDERS



A complete line of Jackson tong type and Martin Wells screw type holders are available in various amperages and sizes.

AIRCO AIR REDUCTION
Offices in Principal Cities

VERSATILE! COMPACT! ACCURATE! FAST! ECONOMICAL!

NEW
JELRUS
'Handy-Melt'
PORTABLE
ELECTRIC MELTING
FURNACE

Handy-Melt PRICE—complete $142.00*
Crucibles $2.50*; Extra Muffle $12.50*
*F.O.B. New York City

For melting, alloying, casting, metallurgical investigation, and many other uses, the new portable Jelrus Electric Melting Furnace really does a *better* job! It's a self-contained plug-in unit (operating on 110 V. AC or DC), light in weight (5 pounds) and really *compact* (12"x10"x9" high).

Furnace capacity permits melts up to 600 dwt. of gold—2 lbs. Avoir. of brass or equivalent—with a simple flick of the switch. Temperature indicator assures consistent results on successive melts. Designed with features that prevent overheating of metal and eliminate metal oxidation, this portable furnace gives maximum service for a modest investment.

Send for Data Sheet Today!

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precision casting sales and engineering

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EQUIPMENT AND SUPPLIES—FACTORY TO YOU!

Finishers! No longer any need to send out your electroplating. **Now you can do it yourself—right in your own shop.** It means QUICKER service, GREATER convenience, MORE PROFITS with **Warner** Equipment and Supplies.

TANK PLATERS
5 TO 100 AMPS

The finest quality made. Post-war engineered for lifetime of use. GUARANTEED capacities with tested ratings. See Catalog for descriptions and prices. FREE . . . see coupon below . . . use it!

Acid Proof Utensils
Covered with Rubber. Can't crack or chip. Includes the Dipper, Pitcher and Funnel.

Felt Polishing Wheels
Designed to give long polishing life. Produce fine surfaces and bright plating.

Buffing Cakes
Includes Emery for coarse polishing, Tripoli for cutting, Red Rouge for brilliancy.

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of Professional Quality

Now you can get EVERYTHING IN ELECTROPLATING from one dependable source. Many items listed in catalog *exclusive with Warner*. No higher quality at any price. Smallest orders get same careful attention as the largest orders. Send for big 40-page Catalog TODAY. It's FREE.

Chemicals in Small Packages

From one ounce to several pounds. COMPLETE STOCK of more than 50 chemicals, ALL TESTED for strength and purity. Includes Copper, Nickel, Silver, Gold plating concentrates and all other chemicals used in Electroplating.

Anodes of Highest Purity

Electrically refined metals, Copper, Nickel, Stainless Steel, Lead-Tin Alloy, 999+ Pure Silver, Zinc, Brass. All in convenient sizes perforated for Vertical or Horizontal suspension.

Big Variety of PLATING EQUIPMENT

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News of... ENGINEERS COMPANIES SOCIETIES

Engineers

George M. Hartley has been named materials engineer for the Chemicals Div. of the General Electric Co.'s Chemical Dept.

The Sillcocks-Miller Co. has just announced the appointment of *John A. Munyak* to head its expanded engineering and technical department.

Three personnel changes in the Technical Div. of E. I. du Pont de Nemours & Co.'s Electrochemicals Dept. include the following. Dr. *Paul R. Austin*, assistant director of the Chemical Dept. laboratory at du Pont's Experimental Station was named director of the Electrochemicals Dept.'s Technical Div. Dr. *Harold J. Barrett*, chemical research manager at the Niagara Falls plant, was appointed manager of field research, with headquarters at Wilmington. And Dr. *Campbell Robertson*, manager of chemical research at the Perth Amboy plant, succeeds Dr. Barrett as chemical research manager at Niagara Falls. Both Dr. *Earle A. Harding*, who has been director of the Technical Div., and *Paul J. Carlisle*, who was manager of field research, will serve as special assistants to their successors until they retire about the end of this year.

Eric G. Skarin has been named service metallurgist for the Ohio Ferro-Alloys Corp. Mr. Skarin formerly was metallurgist at the Midvale Co.

The appointment of *Alex Cruickshank* as plant engineer in charge of maintenance for the McConway & Torley Corp. has been announced. Prior to this new assignment, Mr. Cruickshank served with the New England Metallurgical Corp. and the Jones & Laughlin Steel Corp.

The Latrobe Electric Steel Co. elected the following officers at its recent annual meeting: president, *M. W. Saxman, Jr.;* vice presidents, *D. J. Giles* and *J. E. Workman;* secretary-treasurer, *H. S. Saxman;* assistant treasurers, *G. D. Billock* and *D. E. Lohr.*

J. Kurtz, formerly director of research of the Callite Tungsten Corp., is continuing his activity in the powder metallurgy and carbide field at the Kulite Tungsten Co.

The resignation of *J. B. Neiman* as general manager of the General Aluminum Dept., Federated Metals Div., American Smelting & Refining Co. has been an-

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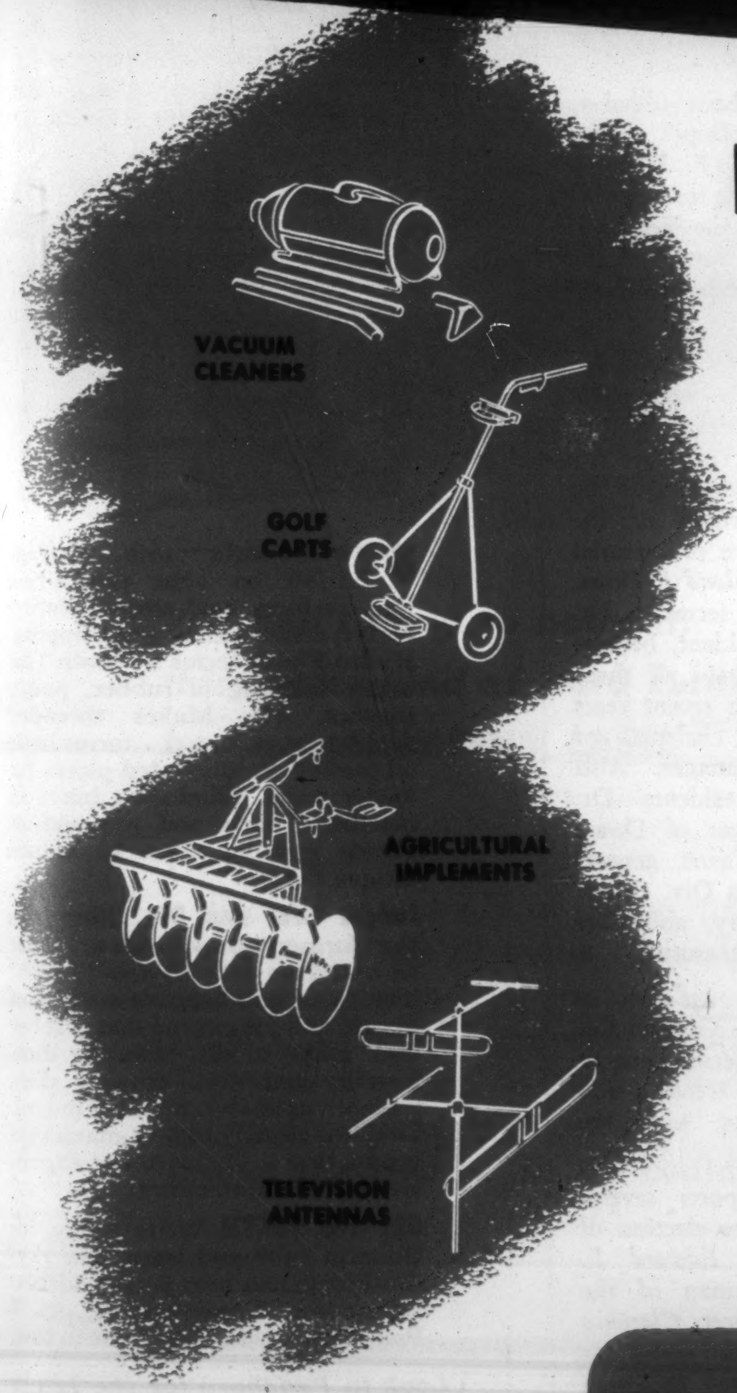

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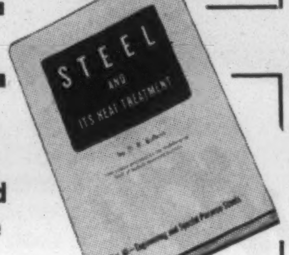

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This is the final volume of the fifth edition of this work that records the latest advances in the metallurgy of steel. It correlates the known facts about the more complicated alloy and special steels and their heat treatment with fundamental principles insofar as the known facts are complete enough and consistent enough to permit. Such steels as carbon, mild alloy, N.E., S.A.E., and tool are discussed. This book covers the effect of heat treatment on the suitability of these steels for various uses as well as the possibilities of utilizing alternate steels.

Volume III is a worthy companion to the first two, which have been acclaimed all over the world with such comments as:

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> —O. O. Miller in *Mining and Metallurgy*

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News of...
ENGINEERS
COMPANIES
SOCIETIES

nounced. Mr. Neiman's headquarters will continue to be at 729 Fisher Bldg., Detroit, Mich., with further details of his plans to be revealed shortly.

Election of officers of the Midvale Co. included the following: *Francis Bradley*, chairman of the board; *Richard T. Nalle*, president; *Lewis W. Metzger*, executive vice president; *Henry H. Ziesing*, vice president in charge of sales; *Charles E. Acker*, secretary; and *Thomas A. Sappington*, treasurer and assistant secretary.

George A. Hays, Jr. has been named director of market development of the Oil Well Supply Co., a U. S. Steel subsidiary. Mr. Hays previously was associated with the Hinderliter Tool Co.

Two new members have been added to the Technical and Research Depts. of the Power Chemicals Div. of E. F. Drew & Co., Inc. *Vincent P. Murphy*, formerly of Hall Laboratories, has joined the Technical Dept. And *John W. Wood*, now with the the Research Dept., had been associated with the Permutit Co.

Several changes in the top executive staff of the Dow Chemical Co. were made recently as a result of the death of Dr. *Willard H. Dow* on March 31st. *Earl W. Bennett*, treasurer and vice president of the company, was elected chairman of the board, but will retain his vice presidential post. The new president is *Leland J. Doan*, formerly a vice president and secretary. Dr. *Mark E. Putman*, a vice president, became general manager. Dr. Dow held all three of the above positions, but in recent years had abandoned the titles of chairman of the board and general manager. Also elected were two new vice presidents—Dr. *A. P. Beutel*, general manager of Dow's Texas Div., and *Russell L. Curtis*, general manager of the Great Western Div. *Calvin A. Campbell* became secretary, and *Carl A. Gerstacker* was elected treasurer.

The resignation of *A. W. Anderson* as vice president of the Claud S. Gordon Co. has been announced. Mr. Anderson, one of the pioneers in modern heat treating and pyrometry, served 31 years with the company.

The Inland Steel Co. reports several changes were made due to the election of its chief executive officers. *Edward L. Ryerson* was re-elected chairman of the board and chief executive officer. *Clarence B. Randall* succeeds *Wilfred Sykes* as president. Mr. Sykes was elected chairman of the executive committee, his period of service with the company being extended beyond the regular retirement date. *Joseph L. Block* was named vice chairman of the board, and will continue as vice president in charge of sales. All other officers of the company were re-elected.

Dr. *Otto Day* has joined the staff of the

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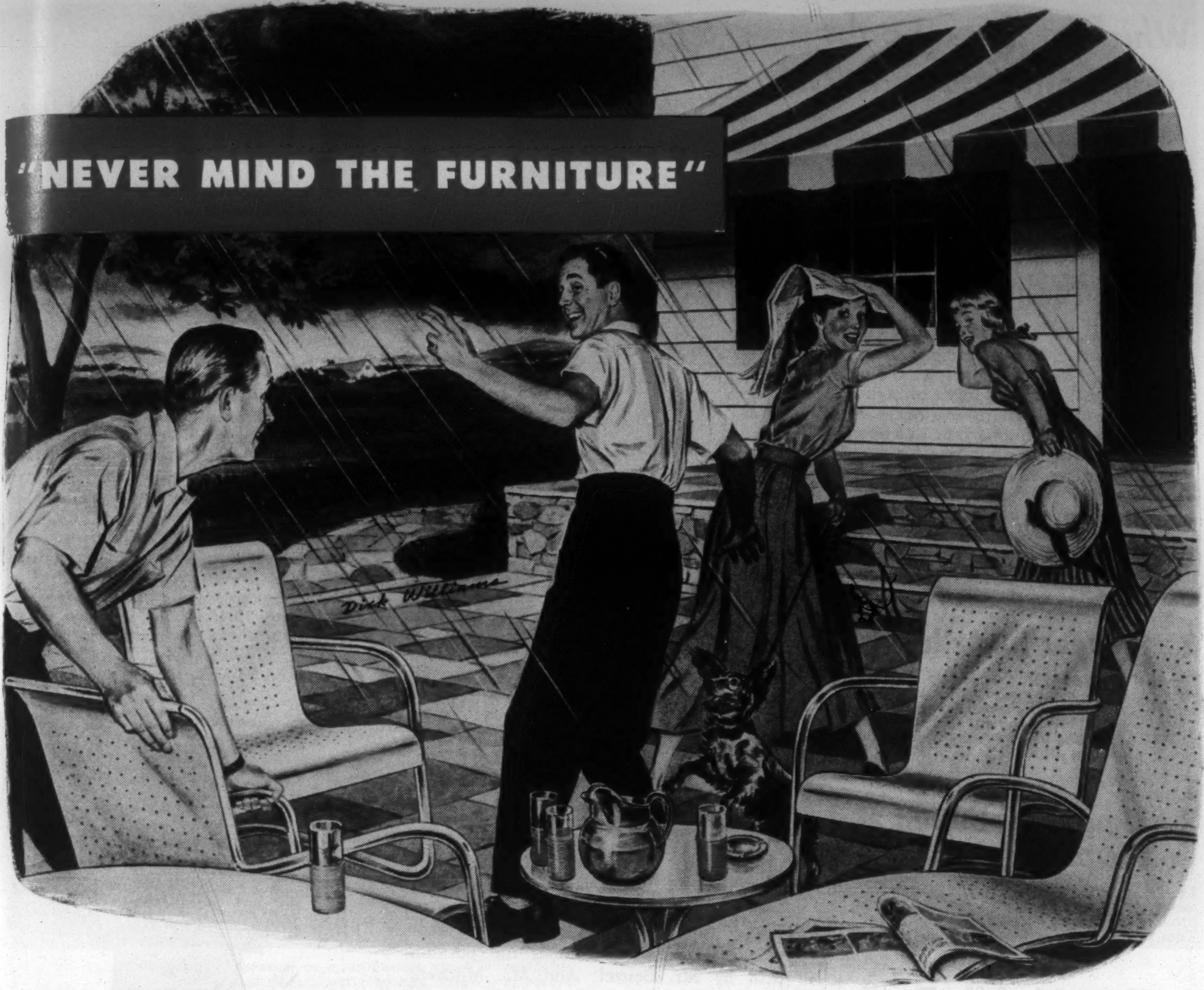

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News of... ENGINEERS COMPANIES SOCIETIES

Armour Research Foundation of the Illinois Institute of Technology, where he will be engaged in research and development work in extraction metallurgy. He formerly was senior chemist in research and development for the Solvay Process Div. of the Allied Chemical & Dye Corp.

The A. F. Holden Co. has promoted *J. B. Carey* to the position of vice president in charge of research and chemical manufacture. *C. R. Hecker* succeeds Mr. Carey as sales manager and export manager. And *C. R. Brown* was named a vice president of the company.

The appointment of *Llewellyn S. Howe* as director of engineering at the manufacturing plant of the Glenn L. Martin Co.'s Chemicals Div. has just been announced. Mr. Howe previously directed all chemical and mechanical engineering activities of the Chemical Div. of Orr & Sembower, Inc.

George B. Beitzel was elected president of the Pennsylvania Salt Manufacturing Co., to succeed *Leonard T. Beale,* who will continue with the company as chairman of the board. *William P. Drake* and *William F. Mitchell* were named vice presidents in charge of sales and of manufacturing, respectively. Mr. Drake, formerly assistant vice president-sales, assumes the position held by Mr. Beitzel. And Mr. Mitchell, previously assistant vice president-manufacturing, succeeds *Y. F. Hardcastle,* who has retired from active participation but remains as a member of the board.

The resignation of *L. A. Ringman* from the National Supply Co. in order to join the Ingersoll Milling Machine Co. has just been announced. *R. E. Volk* has succeeded Mr. Ringman as works manager at National.

The E. W. Bliss Co. announces the appointment of *J. H. Tredinnick* as a vice president of the company. Mr. Tredinnick is manager of Bliss' Hastings, Mich. plant.

Re-election of all the officers of the Bridgeport Brass Co. include the following: *Herman W. Steinkraus,* president and chairman of the board; *Mead W. Batchelor,* vice president in charge of production; *William R. Breetz,* vice president and treasurer; *Michael Schwarz,* vice president in charge of procurement; *Austin R. Zender,* vice president in charge of sales; *John S. Dawson,* secretary; *Everett Japp,* assistant vice president and assistant secretary; and *Warren J. Faust* and *Stanley Z. Bronner,* assistant treasurers.

The National Supply Co. elected *F. W. Bremmer* vice president in charge of manufacturing, filling the vacancy left by the retirement of *Charles R. Barton* a year

(Continued on page 138)

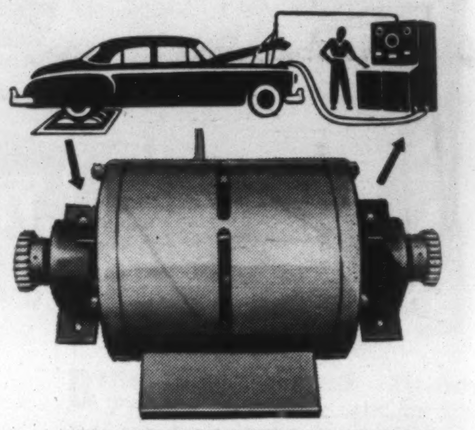
Silicone News

DC SILICONES

Silicones Pay Off In a Buyer's Market

Your customers are demanding more for their money. Offer them better performance, longer life, greater reliability or reduced maintenance costs and they'll listen. Design all four of those basic sales appeals into your product and they'll buy. You can do that in many cases by taking advantage of the exceptional stability of Dow Corning Silicones.

For example, you can give your customers permanent lubrication by using DC 44 Silicone Grease. DC 200 Silicone Fluids enable you to design more compact hydraulic systems or make wider use of viscous damping. You can increase the power per pound ratio in electric machines by 50 to 100 per cent and you can increase the life of electrical equipment by a factor of 10 through use of Dow Corning Silicone—Class "H"—Electrical Insulation.



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DC Silicone Electrical Insulation and DC 44 Silicone Grease improve the performance, cut maintenance and increase the life of E. P. Electric Chassis Dynamometers.

Typical application for Dow Corning Silicone Electrical Insulation is the Electric Chassis Dynamometer made by The Electric Products Company of Cleveland. Complete performance testing of automobile engines without actual road tests makes it necessary for the armature coils to absorb so much energy that operating temperatures are in the range of 400° F. Under such severe conditions, only Silicone Insulation and DC 44 Grease give long and trouble-free service.

Among many other applications, Silicone Insulation is used in building compact, high powered solenoids; portable welding transformers; bus generators and industrial motors. For more information about Dow Corning Silicone Electrical Insulation, write for pamphlet G11BC6.

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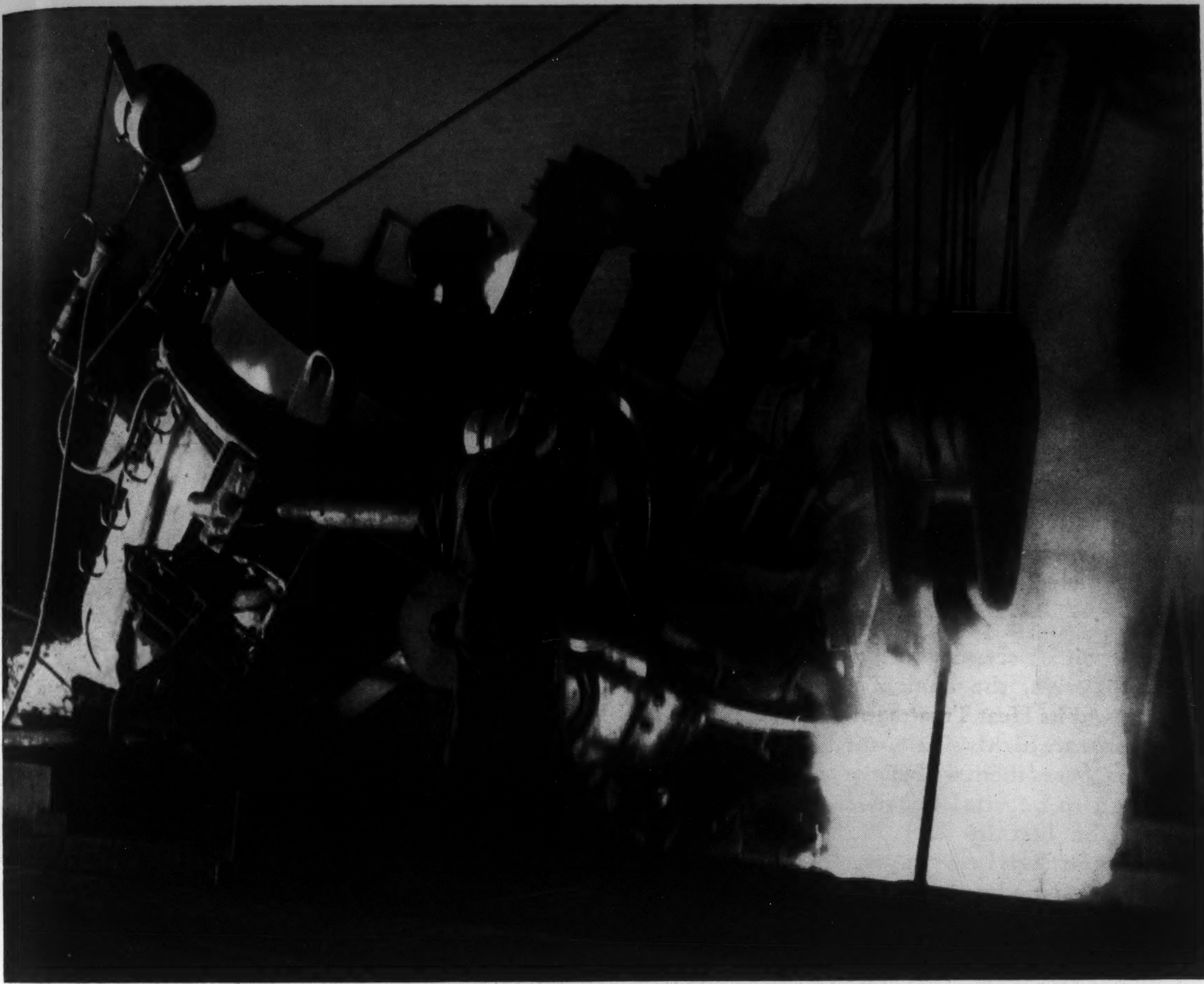

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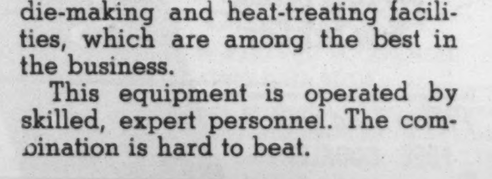

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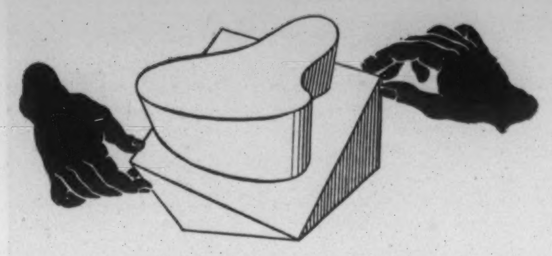

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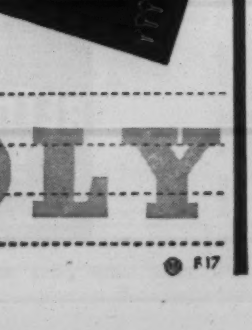

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News of...

ENGINEERS
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SOCIETIES

ago. Mr. Bremmer was works manager of Spang-Chalfant Div.'s Ambridge plant.

F. M. Rich, vice president in charge of operations, has been transferred from the Fontana, Calif., plant of Kaiser Co., Inc. to the Oakland home office. *George B. McMeans,* general superintendent, will be in charge at Fontana.

The appointment of *Tinkham Veale, II* to the post of assistant to the president of the Ohio Crankshaft Co. has been reported. Mr. Veale previously was manufacturing and administrative head of the company's Tocco Div.

The General Cable Corp. elected three vice presidents at a recent meeting: *Samuel A. Smith* will be in charge of research and development; *Oscar G. Garner,* in charge of manufacturing; and *Allen D. Pettee,* in charge of product engineering.

Hugh J. Pugsley has been named vice president in charge of the Combustion Furnace Div. of the Swindell-Dressler Corp.

The Doehler-Jarvis Corp. has elected *E. R. Zabriskie* a director and appointed him a member of the Executive Committee. Mr. Zabriskie is a vice president and general sales manager of the Corporation. Two new vice presidents also were named at the same meeting. They are *Howard W. Bartholomew,* manager of D.-J.'s Pottstown, Pa. plant, and *Robert H. Kitzman,* manager of the Corporation's two plants in Toledo, Ohio.

All officers of the Van Dorn Iron Works Co. were re-elected at a recent meeting. Also added to the group were three new vice presidents—*Harry D. Garber, Charles B. Bednar,* and *Lawrence C. Jones.*

Companies

The *Ajax Electric Co., Inc.* has moved its manufacturing facilities to a new plant located at Tioga & Melville Sts., Philadelphia, Pa. The Ajax business office is still located at Frankford & Delaware Aves. in Philadelphia.

A new stainless steel wire mill at the *American Steel & Wire Co.'s* Waukegan, Ill. plant will be opened officially on June 23. This *U. S. Steel* subsidiary has also formed a new division in its general sales department, to be known as the *Spring Products Sales Div.* Charles W. Meyers will head the new division as manager, with Robert D. Knight as assistant manager. Their headquarters will be in the main offices in Cleveland.

Greatly expanded manufacturing facilities have resulted for the *Amplex Div.* of the *Chrysler Corp.* through the completion

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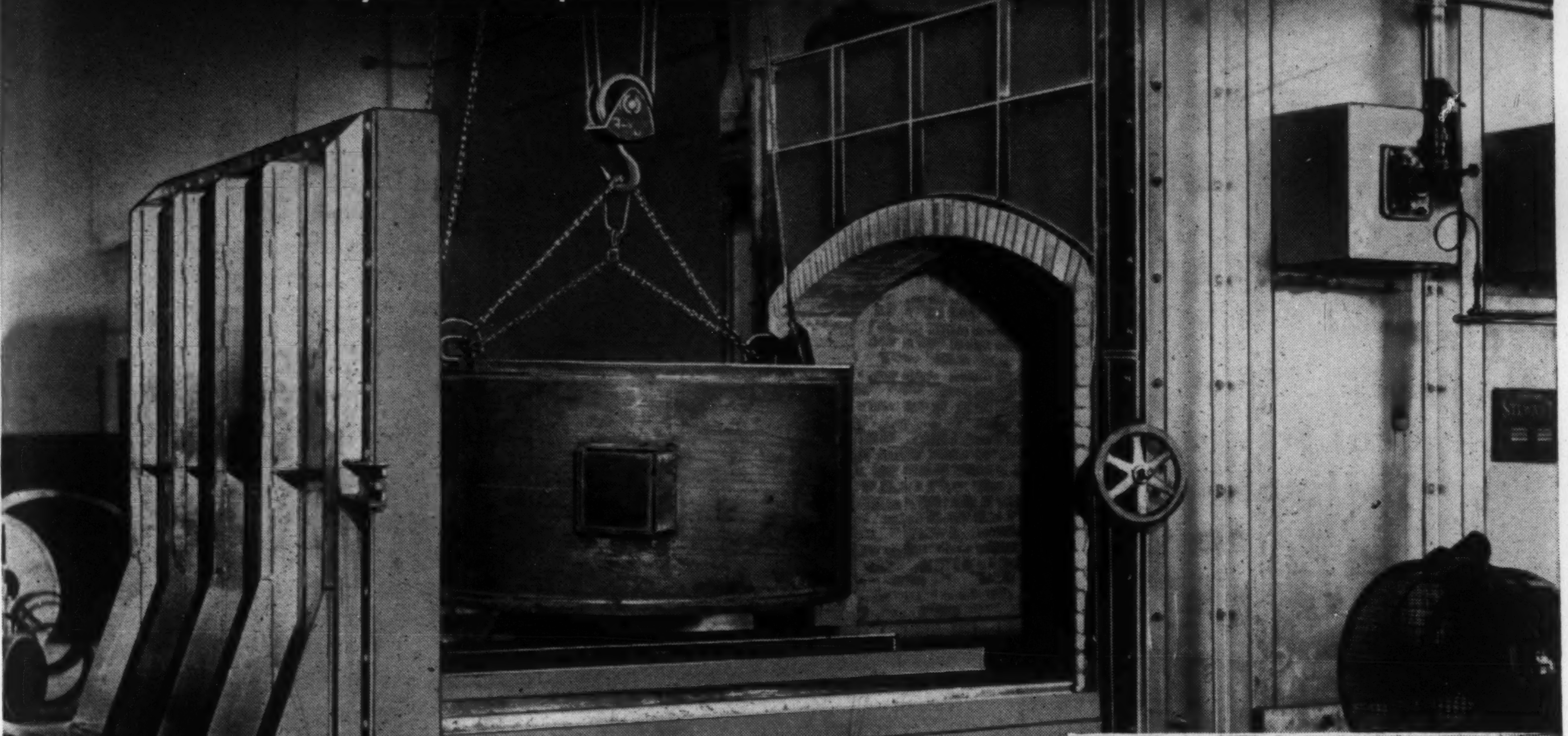

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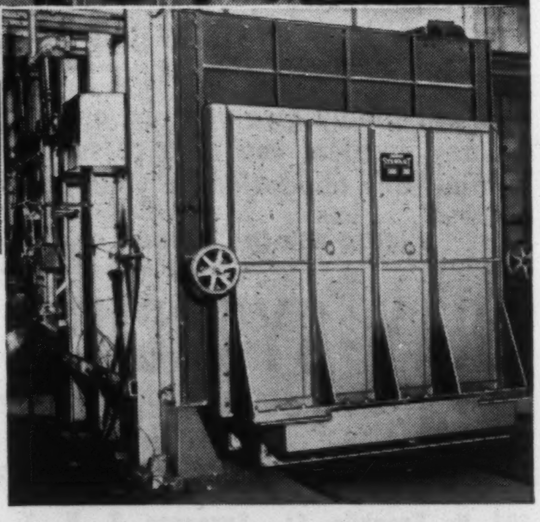

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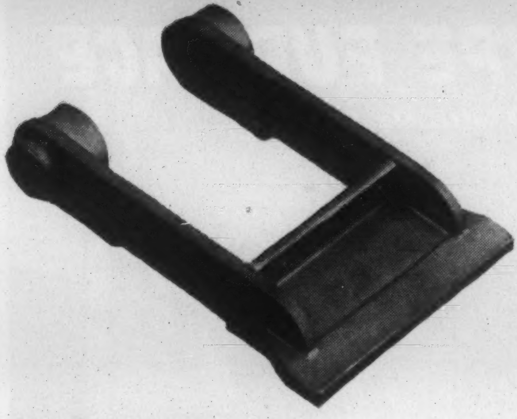

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News of...

ENGINEERS
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of a new plant at 65th St. & Harper Ave., Detroit.

Tinnerman Products, Inc. has moved its New York district office to new and larger quarters at 75 Roseville Ave., Newark, N. J.

The formation of a *Central Research Div.* by the *Ferro Enamel Corp.,* Cleveland, Ohio, has just been announced. The new division, to be directed by Dr. G. H. McIntyre, vice president and director of research of Ferro, will coordinate all corporate research activities.

The *Eutectic Welding Alloys Corp.* has begun production at its newly-acquired Plant No. 2, located in Flushing, N. Y.

The offices of the *Scomet Engineering Co.* have been moved from Lexington Ave. to 61 Broadway, New York 6.

The *U. S. Atomic Energy Commission* has signed a contract with the *U. S. Vanadium Corp.* for the rehabilitation and operation of the Corporation's uranium-vanadium processing plant at Uraven, Col. Full operation of the plant is expected by the end of the year.

Production will get under way this month at the new Kaiser Aluminum rod, bar, wire and cable mill of the *Permanente Metals Corp.,* to be located at Newark, Ohio. Another project of Permanente is the opening of a sales office for the *Permanente Products Co.,* sales affiliate of the Corporation. The new office is situated in the Boston Safe Deposit & Trust Co. Building, Boston, Mass., and will service the New England area. Robert E. Belknap, Jr., formerly president of Griffin-Belknap Co., Inc., will head the office as sales representative of the company.

The general office of the *Ward Leonard Electric Co.* has been moved to 115 S. MacQuesten Parkway, Mt. Vernon, N. Y.

A new *Product Development Dept.* has been established by *E. F. Houghton & Co.,* Philadelphia, to be headed by Dr. H. B. Walker, formerly assistant to Dr. R. H. Patch, vice president-operations of the Company.

The *Copress Corp.* has announced the removal of its factory and office to 523 West Ave., Norwalk, Conn.

A fourth major unit for the continuous production-line coating of flat-rolled steel in a bath of molten zinc or aluminum has been put into operation by the *Armco Steel Corp.,* Middletown, Ohio.

Aluminum has been added to the regular line of metal products available from the *U. S. Steel Supply Co.,* warehousing subsidiary of the *U. S. Steel Corp.* Located in Chicago, it will handle the complete line of aluminum mill and building products of the *Reynolds Metals Co.*

RUST
The biggest THIEF in America!

ALL through the summer . . . through hot, humid days and hot, humid nights . . . the biggest thief in America will be raiding your plant, stealing your profits, stealing your steel!

In every department—where raw steel comes in, where steel parts are stamped or milled or machined or ground, where steel products are pickled or cleaned or assembled—the moisture in the air is always helping that big thief, RUST, to rob you of production—atom by atom — taking pennies and dimes and dollars out of your pocket.

But you don't have to put up with this monstrous moist-month thievery! The Oakite Technical Service Representative in your vicinity can help you fight RUST. He is well equipped with materials for (1) preventing rust, (2) removing rust, (3) cleaning and de-rusting in one operation and (4) simultaneously imparting rust-resistance and improving paint-adhesion.

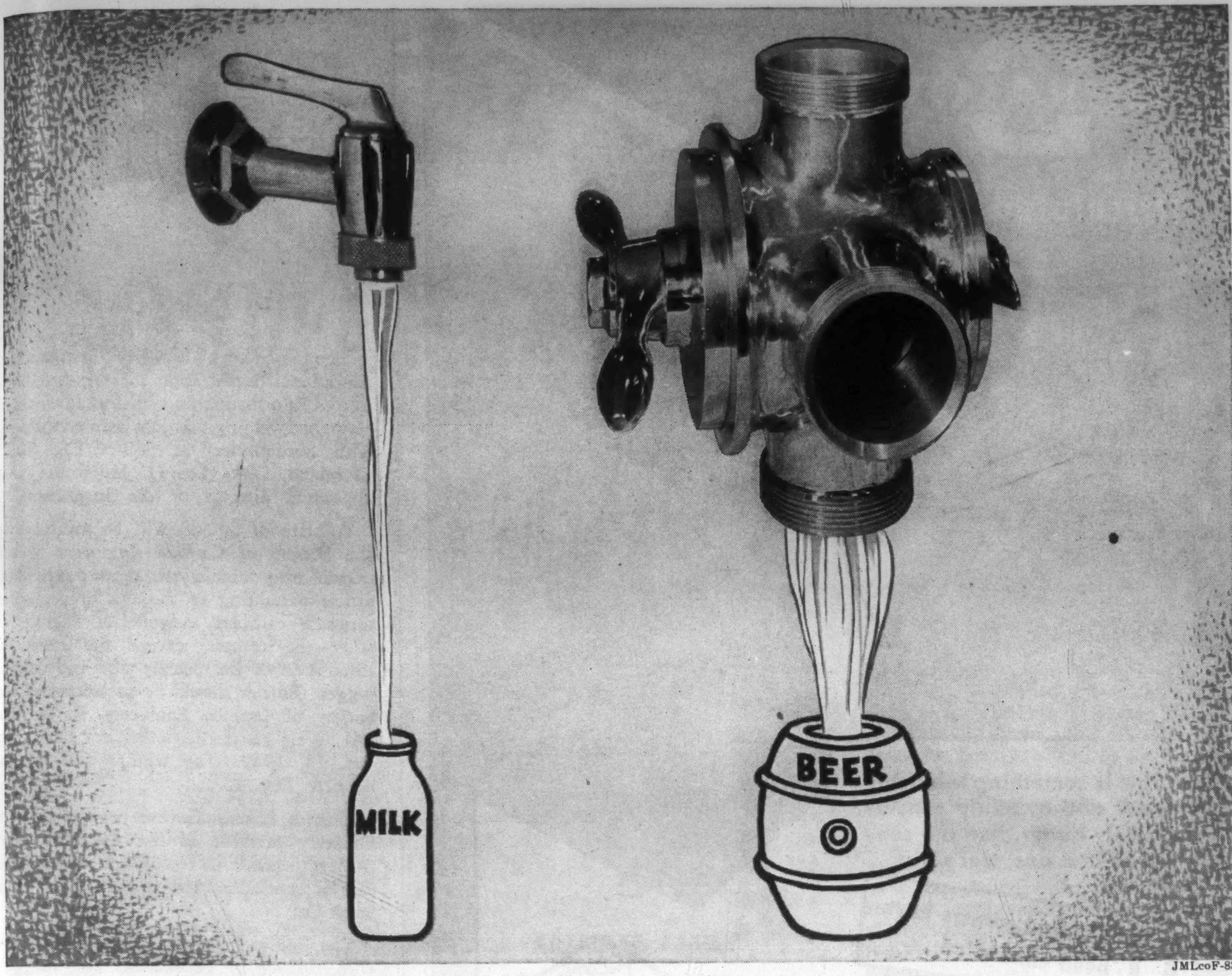
FREE Phone your Oakite Technical Service Representative or write to Oakite Products, Inc., 32H Thames St., New York 6, N. Y., for full information on Oakite methods for arresting RUST in every part of your plant.

OAKITE

OAKITE 1909 1949 40th ANNIVERSARY YEAR

SPECIALIZED INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE

Technical Service Representatives Located in Principal Cities of United States and Canada



MOO JUICE to MALT JUICE!

The small valve is for the dairy industry; the large one for the brewery field. Both are cast of Federated Nickel Silver . . . for very good reason.

Since 1912 the Specialty Brass Company, Kenosha, Wisconsin, has been making castings for dairy equipment. Then, and even more so now, the demands of this food industry forbid the use of castings with even the slightest blemish. Brewery equipment must likewise be virtually perfect.

To produce such castings consistently . . . and to be famous for it . . . Specialty Brass uses the best in methods, and the *best in materials*. Specialty uses Federated Nickel Silver exclusively.

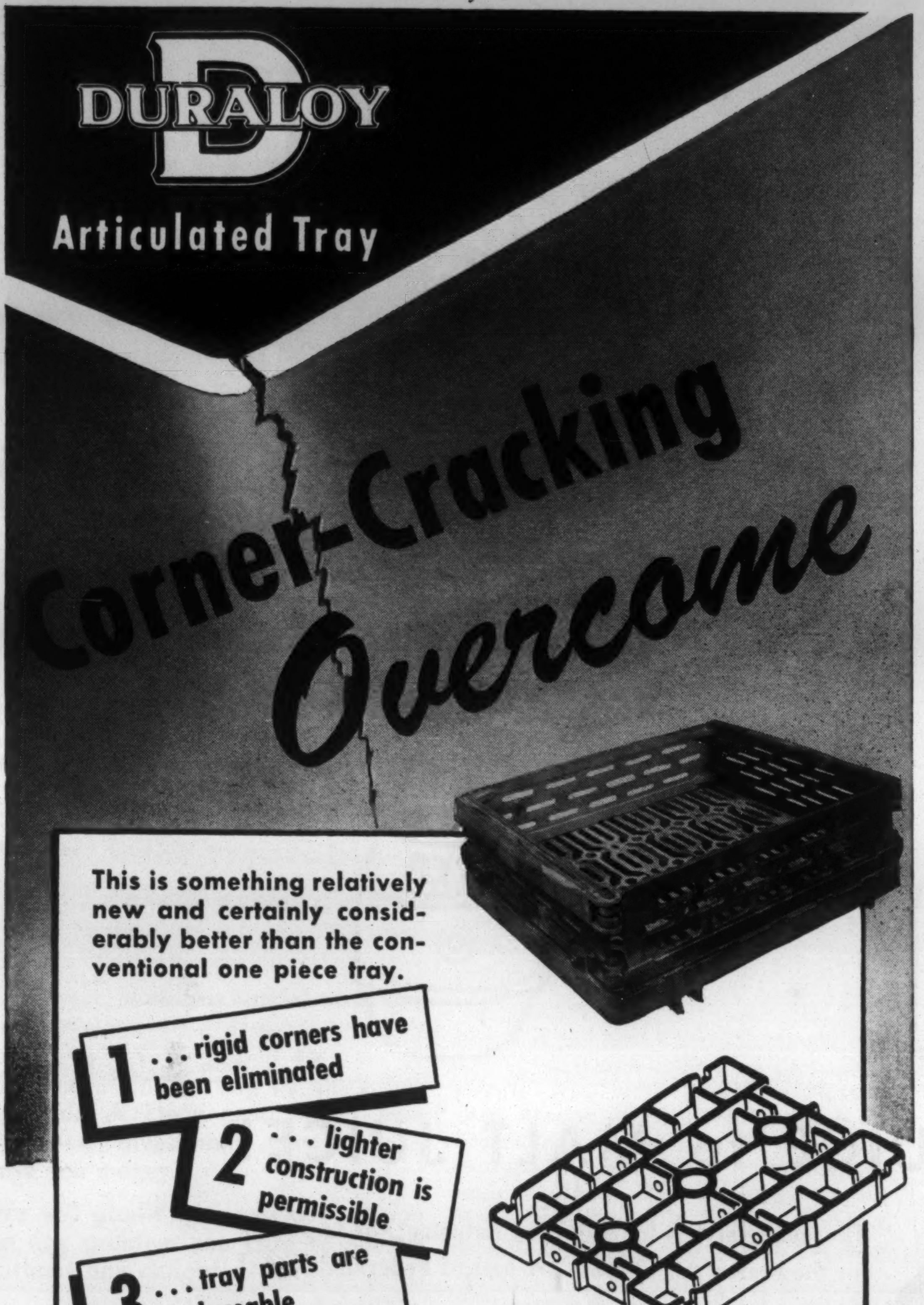
Nickel silver alloys are particularly suited for use where high corrosion resistance and silvery white color are important. Federated metallurgists can tell you exactly what alloy fits your need. They are ready and willing to help out in your foundry, too, should casting problems arise.

For nickel silvers; brasses and bronzes; aluminum and magnesium alloys; solders; babbitts; fabricated lead products; for any non-ferrous metals, see Federated first.

Federated first in the non-ferrous field FMD

Federated METALS DIVISION

AMERICAN SMELTING AND REFINING COMPANY, 120 BROADWAY, NEW YORK 5, N. Y.



This is something relatively new and certainly considerably better than the conventional one piece tray.

1 . . . rigid corners have been eliminated

2 . . . lighter construction is permissible

3 . . . tray parts are replaceable

If you require heat-treating trays in your plant, why not investigate the Duraloy Articulated Tray*? The principle of design permits wide variations in size and shape. Send us a sketch or description of your present trays and we'll design a Duraloy Tray to take its place and let you know what it will cost.

If interested in high alloy castings generally, send for our Catalog 4729-G.

*Patented

THE DURALOY COMPANY

Office and Plant Scottdale, Pa. • *Eastern Office* 12 East 41st Street, New York 17, N. Y.

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1743 McCormick Building, Chicago, Illinois

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F. B. CORNELL & ASSOCIATES

METAL GOODS CORP.: St. Louis · Houston · Dallas · Tulsa · New Orleans · Kansas City

News of...

ENGINEERS
COMPANIES
SOCIETIES

Societies

The *Resistance Welding Institute,* an educational organization for the dissemination of information on technical advances in resistance welding, has just been established, with headquarters at 519 C.T.S. Bldg., Cleveland, Ohio. Lee H. Judge has been appointed director of the Institute.

A prize of $50.00 will be awarded by the *Society of Carbide Engineers* to the person who submits the most outstanding article pertaining to the use of cemented tungsten carbides. Anyone is eligible to enter the contest, except the executive committee of the Society and the contest judges. Entries should be submitted to the Society of Carbide Engineers, P. O. Box 141, West Hartford, Conn., not later than Oct. 15, 1949. The winner will be announced Dec. 8.

Charles Lukens, Sr. has been elected an honorary member of the *American Iron & Steel Institute* in recognition of his 74th year of continuous service with the Lukens Steel Co.

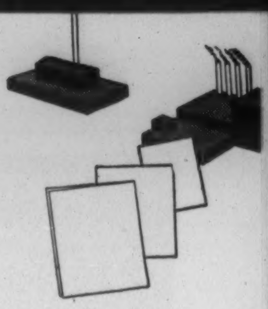
The Public Relations Depts. of the *Illinois Institute of Technology* and the *Armour Research Foundation* have been unified under the general supervision of James W. Armsey.

The *American Zinc Institute* elected the following officers at its annual meeting: president—Edward H. Snyder, president of the Combined Metals Reduction Co., succeeding Howard I. Young; vice presidents—Clarence Glass, Anaconda Sales Co.; George Mixter, U. S. Smelting Refining & Mining Co.; and Raymond F. Orr, Athletic Mining & Smelting Co.; treasurer—Erle V. Daveler, American Zinc, Lead & Smelting Co.; and re-elected as vice president and secretary—Ernest V. Gent.

F. L. LaQue, well-known authority in the field of corrosion, has been named recipient of the Frank Newman Speller Award in Corrosion Engineering. The Award, presented annually by the *National Association of Corrosion Engineers,* is made in recognition of outstanding contributions in science and engineering as pertaining to the field of corrosion.

Lehigh University, in cooperation with the *Society of Industrial Designers,* will sponsor a Product Design Seminar for six weeks, beginning July 5th. Registration will be limited to 50 delegates representing manufacturing companies. Additional information may be secured by writing to Mr. E. M. Ramberg, Dept. of Mechanical Engineering, Lehigh University, Bethlehem, Pa.

(More News on page 148)



MANUFACTURERS' LITERATURE

Materials

IRON AND STEEL

Stainless Steels for Tubing. A convenient reference card, No. TDC-122, on stainless Croloy steels for tubing, giving standard type numbers by which grades are identified, and chemical composition limits and ranges, based on ladle analyses, is offered by the Babcock & Wilcox Tube Co. (1)

Chromium-Molybdenum Steels. Section X-F, a supplement manual to Bliss & Laughlin, Inc.'s 50th anniversary book, consists of six pages of chemical and physical properties and other data of 4120 Type and AISI Grades 4130, 4140 and 4150 cold finished chromium-molybdenum bar steels. (2)

Air Hardening, Wear Resisting Steel. Detailed engineering data on Miscrome 5-Cast, an air hardening, wear resisting steel, are presented by the Alloy Casting Div. of the Michigan Steel Casting Co. in a 2-page bulletin. (3)

Cast Iron Bars. Complete specifications, physical properties, heat treating data, sizes and shapes of Osco Kel-Cast iron bars, made of a specially alloyed and processed cast iron, for use under conditions involving unusual heat, corrosion or wear, are featured in this 4-page, illustrated bulletin, issued by the Ohio Stainless & Commercial Steel Co. (4)

Aircraft Steels. Joseph T. Ryerson & Son, Inc., has just published a 64-page booklet, second edition, containing descriptions, sizes, weights, lengths and extras of carbon, alloy and stainless grades of aircraft quality steel available for immediate shipment from stock. Also included is a condensed listing of AN-QQ, Federal QQ, and AN and AMS Specifications pertaining to steel. (5)

NONFERROUS METALS

Beryllium-Copper Investment Casting. Typical physical and mechanical properties and accepted processing techniques for Berylco 20C, a standard 2% beryllium-copper casting alloy that offers special advantages in investment cast parts, are featured in this 4-page, illustrated bulletin, No. 11, just released by the Beryllium Corp. (6)

Nickel Alloys. The electrical and electronic properties of 18 high nickel alloys, typical uses, their mechanical and other properties, and the various forms in which these alloys are available are all included in this 26-page booklet, offered by the International Nickel Co., Inc. (7)

PARTS AND FORMS

Precision Investment Castings. An interesting article on precision investment castings is presented by the Arwood Precision Casting Corp. in this 16-page, illustrated bulletin, including a table of alloys found by Arwood to be most adaptable to its process. (8)

Short Run Stampings. The many advantages of using short run stampings, including blanking, piercing, forming, drawing, extruding, plus drilling, tapping, etc., are shown in this 4-page, illustrated bulletin, No. 101, describing work done by the Federal Tool & Manufacturing Co. Prices are included. (9)

Rubber Bonded-to-Metal Products. A large variety of rubber bonded-to-metal products, such as wringer rolls, vibration dampeners, compressed rubber bushings, rubber tubing, etc., are profusely illustrated and described in this 8-page bulletin, issued by the Firestone Industrial Products Co. (10)

Laminated Shims. This 8-page, illustrated bulletin, No. 1751-41, discusses Laminum shims, composed of brass laminations alternating with layers of metallic binder, which can be simply peeled to meet required adjustment. The Laminated Shim Co., Inc., also manufactures these shims to exact blueprint specifications. (11)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 145.

Meehanite Metal Applications. The third of a series of new application bulletins, No. 30, describes and illustrates the current uses of Meehanite castings. This bulletin, eight pages, has been published by the Meehanite Metal Corp. (12)

Low-Weight Forgings. An interesting, 16-page, illustrated reprint released by the National Machinery Co. discusses the development of low-weight forgings, which have been designed and produced so as to reduce to a minimum scrap loss in the form of crop ends, flash trimmings and machining chips. (13)

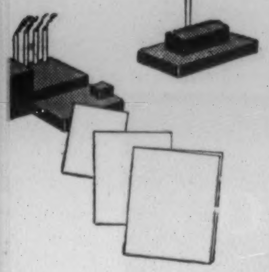
Pressed Powder Parts. The New Jersey Zinc Co. has released the first issue of a new house organ, entitled *Metal Powder Press,* which will be published quarterly. Each issue will contain interesting case histories on nonferrous pressed powder parts. (14)

Metal Powders. This single sheet lists the various metal powders produced by Plastic Metals, Div. of the National Radiator Co., as well as the numerous applications in which these metal powders have been most successful. (15)

Powdered Metal. A broad range of new applications for powdered metal fabrication processes, as well as a table of physical properties of various Powdermet parts, is presented by the Powdered Metal Products Corp. of America in a new 8-page, illustrated bulletin. (16)

Stainless Steel Castings and Specialties. A variety of stainless steel castings, regulator and valve parts, centrifugal pump impellers, etc. are profusely illustrated and described in this 4-page folder, issued by the Stainless Foundry & Engineering Co. One page of the bulletin is filled with helpful engineering data. (17)

Powdered Metal Parts. This 4-page, illustrated bulletin, No. 100, describes how a special combination of three powdered metals are used to produce cylindrical self-lubricating bearings. Other powdered metal parts in iron, steel, etc., are also available from the Wel-Met Co. Specifications and tolerances are included. (18)



MANUFACTURERS' LITERATURE

Fabricated Wood. The facilities of Woodall Industries, Inc., for fabricating to specification industrial Masonite, a versatile material that can be used to better advantage than wood, plywood, sheet metal or paper stock boards, are profusely illustrated and described in this 16-page brochure. (19)

PLASTICS

Thermoplastic Cellulose Ester Materials. This 8-page, illustrated bulletin, No. H 1-10, gives complete data on Kodapak Sheet, a thermoplastic cellulose ester material with important applications in the electrical industry. Available in two types—Kodapak 1, cellulose acetate, and Kodapak II, cellulose acetate butyrate—from the Cellulose Products Sales Div. of the Eastman Kodak Co. Specifications are included. (20)

Plastic Molding Materials. The history and development of Plaskon molding materials, their electrical properties, chemical and heat resistance, translucency and moldability are all reviewed in a new, illustrated brochure just released by the Plaskon Div. of the Libbey-Owens-Ford Glass Co. (21)

NONMETALLICS

Ferromagnetic Ferrite Material. This 8-page, illustrated bulletin, No. B-1179, gives detailed engineering data on Norelco Ferroxcube III, a ferromagnetic ferrite material used in cores for inductors and transformers. Available from the North American Philips Co., Inc. (22)

Methods and Equipment

HEAT TREATING

Continuous Reciprocating Furnaces. Bulletin No. 815A, two pages, gives complete specifications on three models of continuous reciprocating furnaces—No. 176-G, a full muffle, controlled atmosphere type; No. 166-C, a full muffle, controlled atmosphere type; and No. 166-BH, an open hearth type. Available from the American Gas Furnace Co. (23)

Super Refractories for Heat Treat Furnaces. A concise description of a variety of super refractories for heat treat furnaces, their physical characteristics, how they are applied to specific types of furnaces, operational advantages, installation data, and numerous tables comprise this 40-page, illustrated bulletin offered by the Refractories Div. of the Carborundum Co. (24)

Electric Industrial Box Furnaces. Three sizes of electric industrial box furnaces for tool room and production heat treating where even temperatures are essential in all parts of the heating chamber, are described in this 2-page, illustrated bulletin, No. 77, issued by the Cooley Electric Manufacturing Corp. (25)

Gas Fired, Oil Fired and Electric Furnaces. A large variety of gas fired, oil fired and electric furnaces for sintering metal powder products and other processes are illustrated and described in this 4-page bulletin, issued by the Electric Furnace Co. (26)

Heat Treating Baths and Furnaces. A variety of bath applications, their uses, melting point and operating range, for ferrous and nonferrous metals, using Holden heat treating baths and furnaces, are presented in tabular form in this 4-page, illustrated bulletin, released by the A. F. Holden Co. (27)

Small Conveyor Furnace. A 3-in. wide belt conveyor furnace for bright annealing, soft soldering, silver brazing and sintering is described and illustrated in this 4-page bulletin, No. CF-3, issued by Sargeant & Wilbur, Inc. Detailed specifications are included. (28)

Refractory. Bulletin No. 168, a single sheet, describes and illustrates Wesgo Super Refractory, a ceramic material available in a variety of shapes for many sintering, annealing, melting, brazing and other heat treating applications. Produced by the Western Gold & Platinum Works. (29)

Steel Hardening Compound. Complete data on Hi-Speed-It, a steel hardening compound consisting of an activated carbon steel catalyst for use in drilling, punching, cutting, chipping, caulking, gouging, or other metalworking operations, are presented by the Wilson Carbon Co., Inc., in an 8-page pocket-size, illustrated folder. (30)

WELDING AND JOINING

Gas Welding Supplies. The mechanical properties, recommended applications and specifications of a complete line of gas welding rods, fluxes, carbon rods, etc., are included in a 16-page, indexed bulletin, offered by the Air Reduction Sales Co. (31)

Stainless Steel Fasteners. All types and sizes of stainless steel machine, self-tapping, socket, set and wood screws, nuts, bolts, washers, rivets and pins are described and illustrated in bulletin No. 49E, over 80 pages, offered by the Allmetal Screw Products Co. (32)

Screws. The Blake & Johnson Co. lists four basic improvements in its Twin-Fast screws—relieved shank diameter, parallel two threads, cylindrical construction, and single, centered point—that assure more accurate, faster, neater and tighter fastenings in both wood and plastic assemblies. This 4-page, illustrated bulletin includes helpful diagrams. (33)

Industrial Fasteners. Time and money-saving case histories that show how Bostitch machines for stapling and wire stitching render better and faster work are reviewed by Bostitch in its 16-page, illustrated bulletin, No. PTG 223. (34)

Welding Positioners. A profusely illustrated circular of Cullen-Friestedt Co. examines the factors involved in handling weldments of various sizes and shapes, and describes the use of positioners to provide economy, convenience and safety. (35)

Neoprene Adhesive. The unique properties of adhesives based on neoprene compositions for providing high bond strengths are discussed in the lead article of *The Neoprene Notebook*, No. 42, published by the Rubber Chemicals Div. of the E. I. du Pont de Nemours & Co. (Inc.). These 12 pages also contain several other short articles on neoprene V-belts, neoprene latex, etc. (36)

Brazing Type Alloy. Numerous applications of EutecRod 16 FC, a strong brazing type alloy that bonds steel at only 1300 F, with 2 to 3 times more strength than a braze, are profusely illustrated and described in this 6-page folder, released by the Eutectic Welding Alloys Corp. (37)

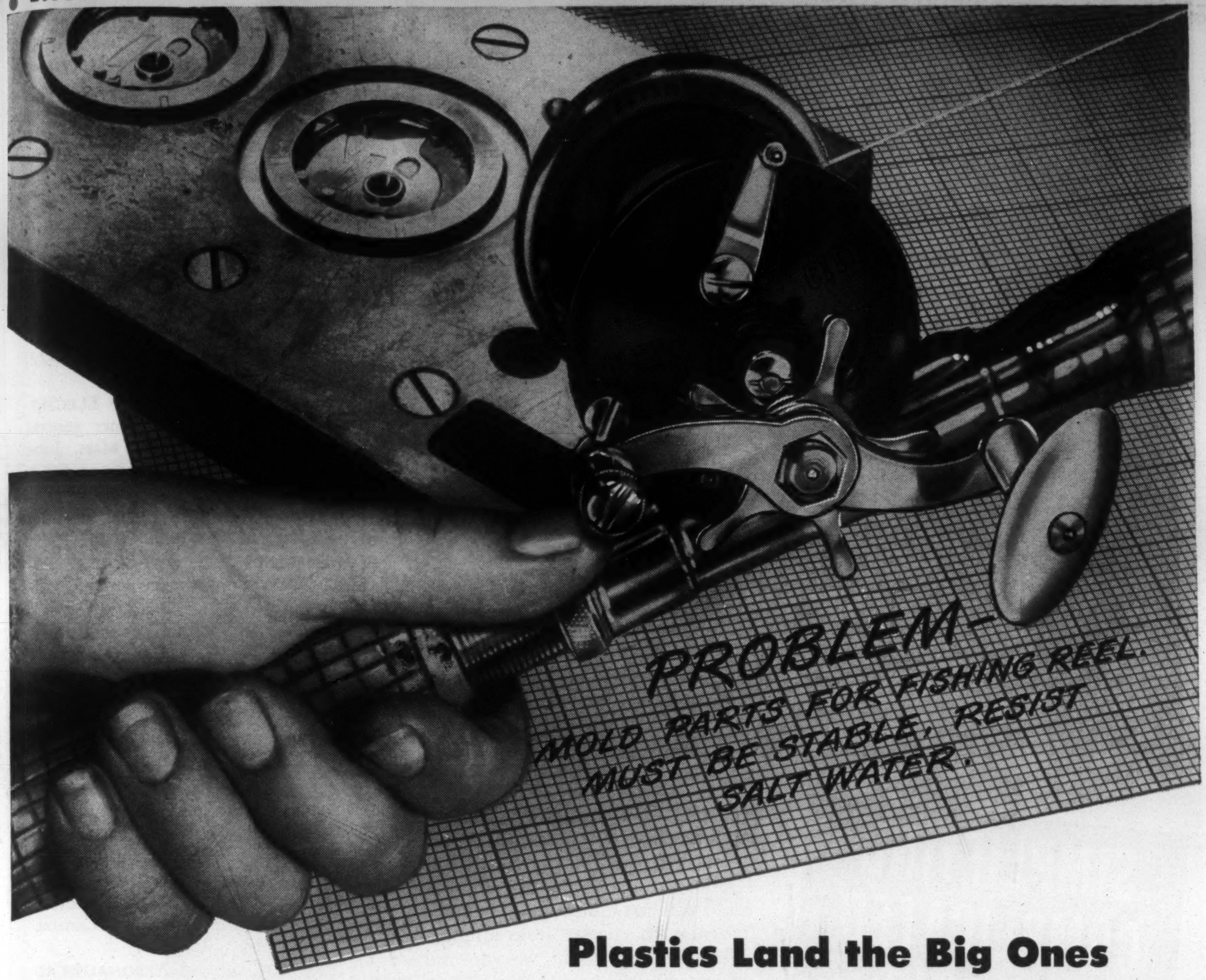
Special Nails, Rivets, Screws. John Hassall, Inc., offers a bulletin describing its complete line of special nails, rivets and screws, made in diameters from 1/32 to ⅜ in., lengths up to 7 in., in a variety of metals and finishes. (38)

Arc Welders, Electrodes, Etc. A complete line of "Simplified" arc welders, electrodes and accessories produced by the Hobart Brothers Co. is profusely illustrated and described in this 8-page bulletin, No. J-2708. Detailed specifications are included. (39)

Self-Locking Connectors. Typical applications in both mechanical and electrical industries of a variety of self-locking push-button connectors, produced by the Interlock Corp., are profusely illustrated and described in this 8-page folder. (40)

Arc Electrodes for Welding Cast Iron. This 4-page, illustrated bulletin, No. 465, presents the application, properties, procedure and typical applications of Ferroweld, a shielded arc electrode of the mild steel type for welding cast iron, and of Softweld, a shielded arc electrode for depositing a soft-machinable nonferrous alloy on cast iron. Available from the Lincoln Electric Co. (41)

ENGINEERED IN PLASTICS BY GENERAL ELECTRIC



Plastics Land the Big Ones

Plastics go fishing! Major parts for the Inductor salt water surf casting reel are molded by General Electric for the Ocean City Manufacturing Co., Philadelphia, Pennsylvania. For this job, G-E formulated a tough, durable plastics material of high impact strength. It is unaffected by salt water. And General Electric alnico permanent magnets are built into this reel to form a new, magnetic "anti-backlash" brake.

You may not manufacture fishing reels, but it's likely that plastics have a place in *your* business. General Electric's *complete* plastics service can work for you—to design, engineer, and mold plastics parts to meet your individual needs. Take advantage of this unique service—discover how often it can lower your costs, improve your products.

Write us for more information, outlining your requirements. Or contact your nearest G-E sales office. We'll be glad to send you, free, the interesting, informative booklet, "Design Data on Plastics." Address: Plastics Division, Chemical Department, General Electric Company, 1 Plastics Avenue, Pittsfield, Massachusetts.

G-E COMPLETE SERVICE—AT NO. I PLASTICS AVENUE

Backed by 54 years of experience. We've been designing and manufacturing plastics products since 1894. General Electric research facilities have expanded continually, working to develop new materials, new processes, new applications for plastics parts.

No. I Plastics Avenue—complete plastics service—engineering, design, mold-making. G-E industrial designers work with our engineers to create plastics parts, sound and good looking. Skilled mold-makers in G-E toolrooms average over 13 years experience.

All types of plastics. Compression, injection, transfer and cold mold facilities . . . high and low pressure laminating . . . fabricating. G-E Quality Control—a byword in industry, means as many as 160 inspections and analyses for a single plastics part.

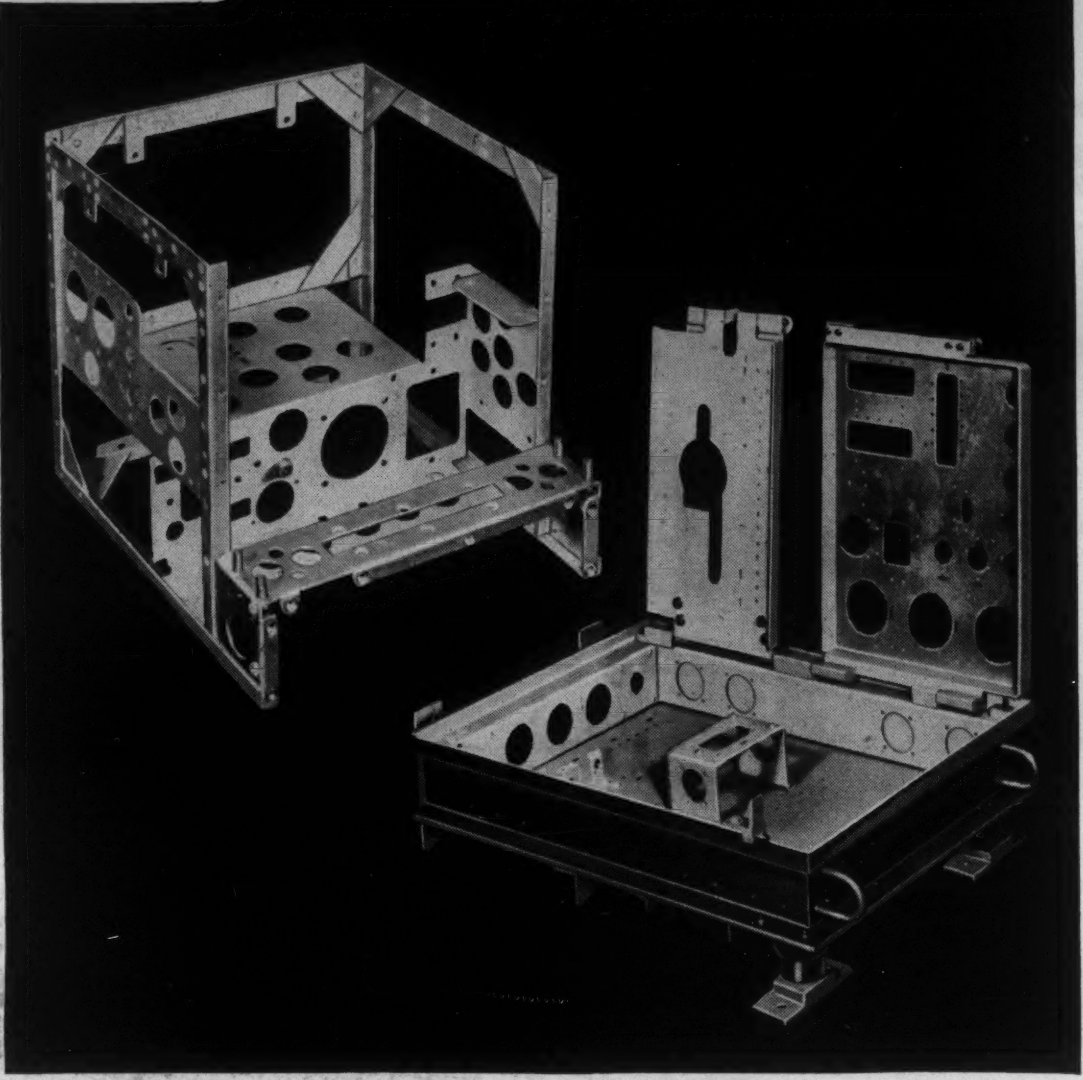
EVERYTHING IN *Plastics*

GENERAL ELECTRIC

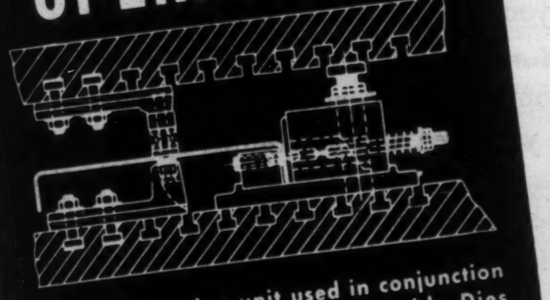
CD48-A38

General Electric plastics factories are located in Scranton, Pa., Meriden, Conn., Coshocton, Ohio, Decatur, Ill., Taunton and Pittsfield, Mass.

WHISTLER ADJUSTABLE DIES...USED BY OVER 1000 MANUFACTURERS



SIMPLIFYING COMPLICATED PIERCING OPERATIONS...



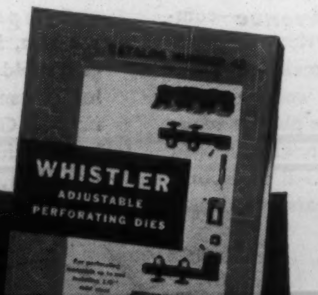
HU-50 Perforating unit used in conjunction with standard Whistler Adjustable Dies on the same job.

LEADING manufacturers find it fast, simple, accurate, and economical to use Whistler Adjustable Dies for the tough jobs. Complicated patterns can be set up quickly. It's easy to change hole arrangements too...without waiting and at no extra die cost. New HU-50 units, that pierce at 90° angle, can be used in conjunction with standard perforating equipment. Fewer press operations are necessary.

Savings, through continued reuse of the same dies in different arrangements on many jobs, are most important.

Whistler Adjustable Dies can be used in practically every type press. Standard sizes of punches and dies up to 3″ are available in a hurry. Only a few days are necessary to get special shapes made to order.

S. B. WHISTLER & SONS, INC.
756 Military Road Buffalo 17, N. Y.



For more details on this modern way to speed production and save money, write for your copy of the Whistler catalog.

Meetings and Expositions

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Applied Mechanics Div. conference. Ann Arbor, Mich. June 13-15, 1949.

MALLEABLE FOUNDERS' SOCIETY, annual meeting. Hot Springs, Va. June 16-17, 1949.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, semi-annual meeting. Minneapolis, Minn. June 20-22, 1949.

NATIONAL ASSOCIATION OF PURCHASING AGENTS, annual convention, Chicago, Ill. June 20-22, 1949.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, summer general meeting. Swampscott, Mass. June 20-24, 1949.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION, annual meeting. Troy, N. Y. June 20-24, 1949.

AMERICAN ELECTROPLATERS' SOCIETY, annual convention. Milwaukee, Wisc. June 27-30, 1949.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, semi-annual meeting. San Francisco, Calif. June 27-30, 1949.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting. Atlantic City, N. J. June 27-July 1, 1949.

AMERICAN SOCIETY OF CIVIL ENGINEERS, summer convention, Mexico City, Mex. July 13-15, 1949.

MAGNESIUM ASSOCIATION, midyear meeting. Niagara Falls, Canada. July 14-15, 1949.

INSTITUTE OF THE AERONAUTICAL SCIENCES, summer meeting. Los Angeles, Calif. July 21-22, 1949.

PRESSED METAL INSTITUTE, national conference. Cleveland, Ohio. July 21-22, 1949.

WESTERN PACKAGING EXPOSITION. San Francisco, Calif. Aug. 9-12, 1949.

SOCIETY OF AUTOMOTIVE ENGINEERS, West Coast meeting. Portland, Ore. Aug. 15-17, 1949.

NATIONAL ASSOCIATION OF POWER ENGINEERS. Chicago, Ill. Aug. 23-26, 1949.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Instruments & Regulators Div. conference. St. Louis, Mo. Sept. 12-16, 1949.

INSTRUMENT SOCIETY OF AMERICA, annual meeting. St. Louis, Mo. Sept. 12-16, 1949.

SOCIETY OF AUTOMOTIVE ENGINEERS, tractor meeting. Portland, Ore. Sept. 13-15, 1949.

PORCELAIN ENAMEL INSTITUTE, annual forum. Columbus, Ohio. Sept. 14-16, 1949.

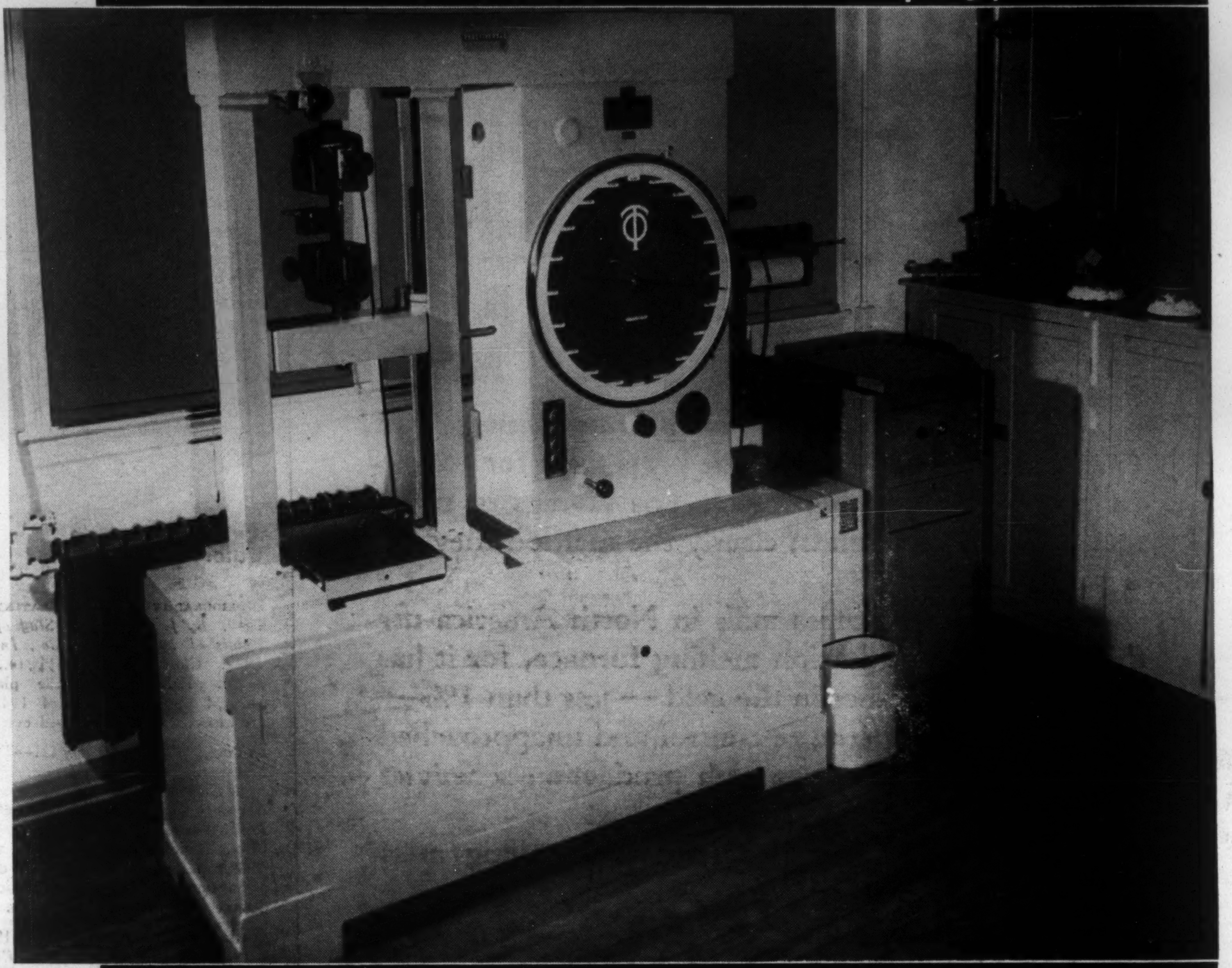
AMERICAN CHEMICAL SOCIETY, national meeting. Atlantic City, N. J. Sept. 18-23, 1949.

★ FOR RESEARCH

★ FOR QUALITY CONTROL

★ FOR PRODUCTION TESTING

Research tension testing. Producing stress-strain curves with Olsen Plastiversal equipped with Olsen Electronic High Magnification Recorder.



it's the

OLSEN PLASTIVERSAL

THE UNIVERSAL TESTING MACHINE FOR

PLASTICS

Courtesy of National Vulcanized Fibre Co., Wilmington, Delaware

WITH the Olsen Plastiversal you are assured of dependable, economical and accurate testing of all types of plastic materials, whether these tests are run on film, sheet, plates or blocks, molded specimens or other parts. It is easy to plot stress-strain curves when the Plastiversal is equipped with the Olsen High Magnification Recorder.

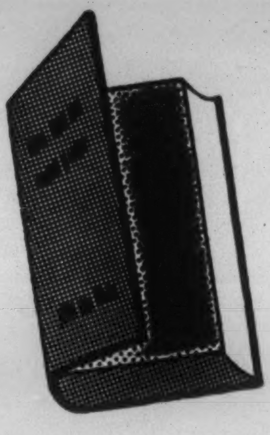
The Plastiversal by its very simplicity of design—operating parts are at a minimum—will keep maintenance costs low while making test after test for comparison, standardization, control and development of plastic materials.

Write today for our NEW Bulletin #36 which includes, not alone the Plastiversal, but many other Olsen machines designed specifically for plastics.

TINIUS OLSEN

Testing & Balancing Machines

TINIUS OLSEN
TESTING MACHINE CO.
2010 Easton Rd., Willow Grove, Pa.



BOOK REVIEWS

Engineering Laminates

Engineering Laminates. *Edited by A. G. H. Dietz. Published by John Wiley & Sons, Inc., New York, 1949. Cloth, 6¼ x 9¼ in., 797 pages. Price $10.00.* Laminates of engineering significance are discussed in this book which contains information of interest to those concerned with the design, manufacture, and use of structural materials. The mechanics of laminate materials from basic properties through physical and chemical properties, to industrial uses, is explained.

Among the laminates discussed are composites of essentially all one class of material such as wood or metal, composites of widely different materials such as plastic or rubber and fabric, composites essentially the same density throughout, and composites of lightweight cores and denser stronger skins commonly referred to as sandwich structures. An attempt has been made throughout to emphasize the engineering properties of the materials.

Chapter titles are: The Strength of Laminates and Sandwich Structural Elements; Adhesives; Glued-Laminated Wood; Plywood; Composite Laminated-Wood-Concrete Construction; Plastics-Based Laminates; Thermostat Metals; Aluminum-Clad Products; Hot-Dipped Aluminum-Coated Steel; Copper and Copper-Alloy Clads; Nickel-Clad, Monel-Clad, and Inconel-Clad Steel; Stainless Clad Steel; Cast Laminated Metallic Materials; Hardness and Wear Resistance—Hard Surfacing by Fusion Welding; Sprayed Metal; Glass-Lined Steel Equipment; Composite-Glass Structures; Sandwich-Type Building Boards Having Insulation-Board Cores; Plastic-Surfaced Plywoods and Their Properties: Structural-Sandwich Construction; Rubber Laminates; Molding Laminates and Sandwich Materials.

Other New Books

Bibliography of the Platinum Metals, 1931-1940. *By J. L. Howe & Staff of Baker & Co., Inc. Published by Baker & Co., Inc., Newark, N. J., 1949. Cloth, 7½ x 11¼ in., 248 pages. Price $5.00.* References to the platinum metals are brought up to the end of 1940. Future volumes are expected to be published every ten years.

Diamond Tool Patents III—Truing of Grinding Wheels. *By W. Jacobsohn. Published by Industrial Diamond Information Bureau, Industrial Distributors (Sales), Ltd., London, E. C. 1, England, 1948. Paper, 7¼ x 9½ in., 87 pages. Price 12/6d.* Lists, classifies and abstracts about 500 British, American and German patents dealing with design, arrangement, or use of a particular truing device. Covers the years 1916 to 1946.

Standard Metal Directory 1948-49—11th Edition. *Published by the Atlas Publishing Co., New York, 1949. Cloth, 6¼ x 9¼ in., 998 pages. Price $15.00.* This useful reference is now divided into five sections—iron and steel plants; ferrous and nonferrous metal foundries; metal rolling mills; smelters and refiners of nonferrous metals; and a new section, "Metal Products Index," which lists geographically distributors of steel and metal products, arranged according to commodities.

Oxygen Cutting. *By E. Seymour Semper. Published by Louis Cassier Co., Ltd., London, S. E. 1, England, 1949. Cloth, 5¾ x 8¾ in., 150 pages. Price 10s. 6d.* Practice in manual and machine cutting with oxygen.

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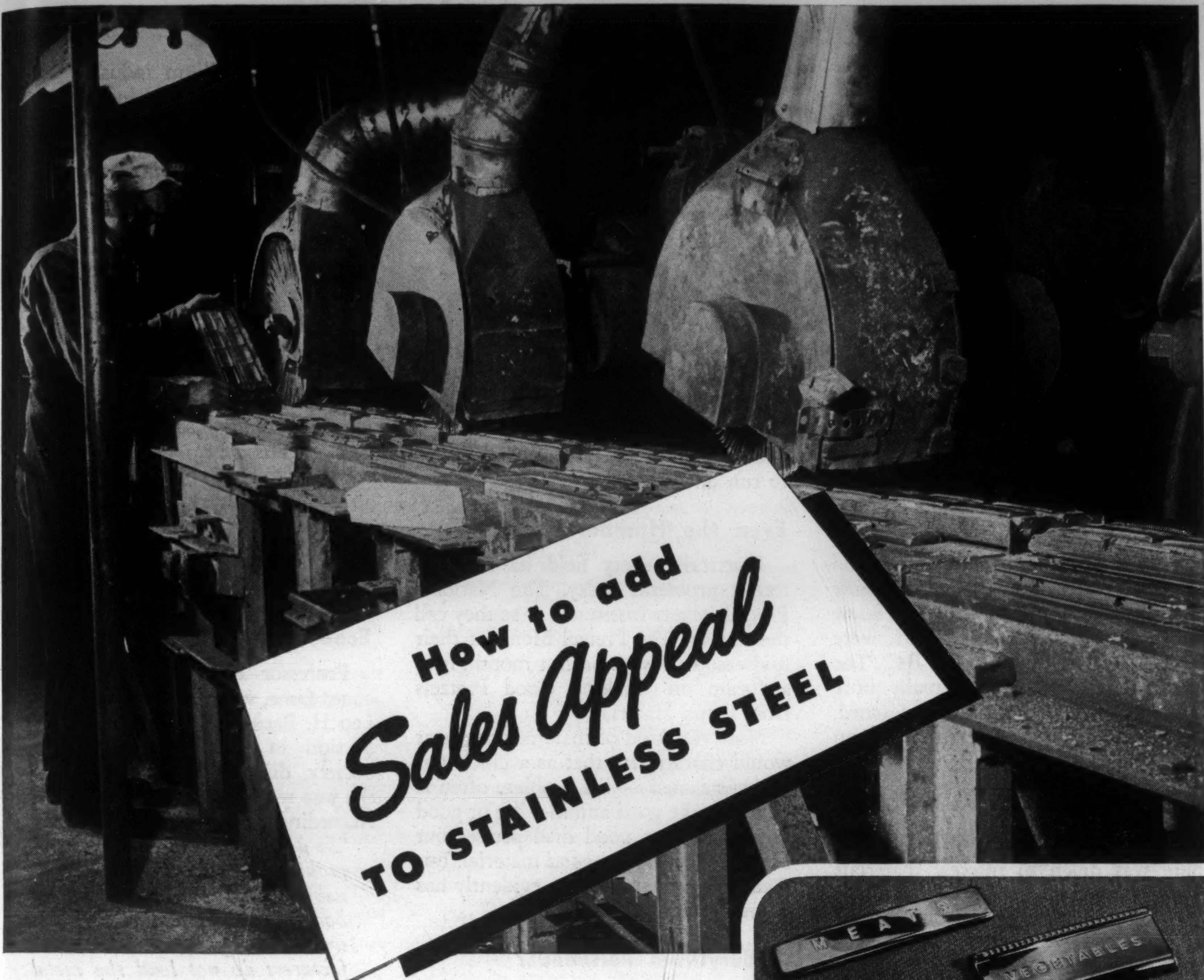

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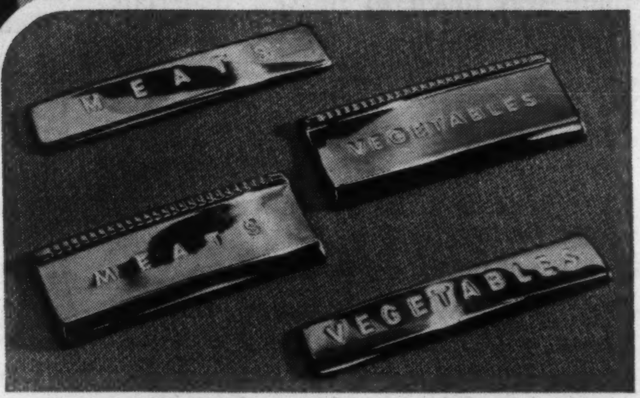

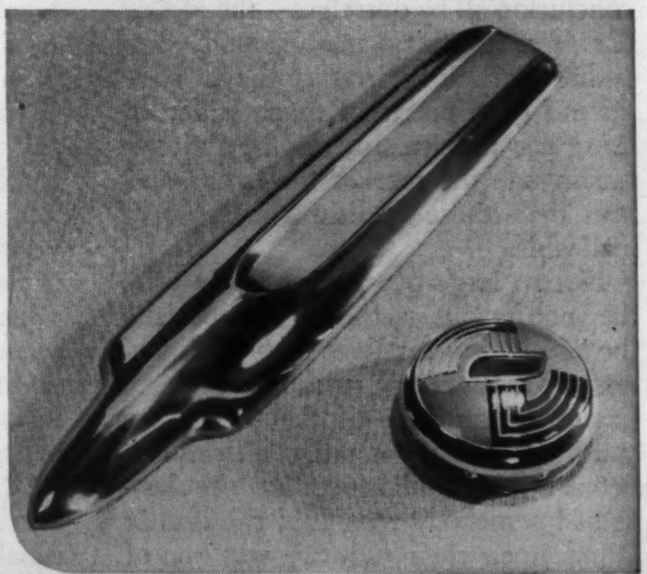

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The Last WORD

by FRED P. PETERS, *Editorial Director*

Old Gold

COLUMBUS, OHIO, MAY 11 . . . Ohio State University has just released the results of research showing that metallurgists of ancient Rome and Macedon were able to produce highly purified gold over 2000 years ago. Some of the gold coins examined were minted in the fourth century B.C. The report that these coins actually bore B.C. dates on them is, we have learned, a malicious slander originating in Ann Arbor, Mich.

Cast Materials

At the A.F.S. convention in St. Louis there was much to interest materials engineers, to whom castings are the No. 1 fabricated material, at least in point of tonnage.

Nodular graphite iron stole the show with the largest attendance ever recorded for an A.F.S. technical session, indicating the tremendous interest in and possibilities for this new cast ferrous metal. While the future market, patent control, manufacturers and other factors are still not clear, we drew one conclusion all by ourselves—the *malleable* iron industry may actually find nodular graphite iron to be a boon instead of a potential menace, for by using the new treatments the industry can invade the market for larger castings than those traditionally made of malleable.

Not so large but just as lively were the nonferrous gatherings, especially the "designing for light alloy castings" session, the meeting of the Centrifugal Casting Committee of the Aluminum and Magnesium Div. and the Brass and Bronze Div. Luncheon. At the last-named somebody rose, told the bronze foundrymen their industry was one of the most backward of all, and was rewarded for this foolhardy libel with such distinguished and delicate abuse and invective as only bronze foundrymen, properly stimulated, can deliver.

Bon mot of the month is Stanley Brinson's definition of a Foundry Expert: A man who knows too much about foundry operations ever to try to run one.

Even the Humble Pretzel

Practically every field has its materials problems today. The National Pretzel Bakers Institute (or as they call themselves, The Pretzel Men) at their midseason convention last month, held a forum on "Making Good Pretzels from Good Material."

Now, our kind of materials engineer would characterize that as a cinch (or perhaps a snap)—the problem often is how to make good automobiles or good refrigerators or good drill presses out of sometimes *not-so-good* material. But then, the pretzel business evidently has its own twists!

Is Beryllium Poisonous?

Everyone by now is generally aware of the poisonous nature of certain beryllium compounds, especially those used in fluorescent tubes. Many, however, have inaccurately extended the stigma to apply also to metallic beryllium, and the fabricators and users of beryllium-copper have had new industrial relations problems to contend with, thereby.

Inquiries that we have made of medical authorities, expert in beryllium toxicology (*e.g.* The Medical Advisory Committee on Beryllium), indicate that beryllium metal and alloys containing it are of themselves not toxic: (1) A potential health hazard may exist in plants in which beryllium ores or compounds are treated to produce the metal, but the hazard is incident to the ore or compound and not to the metal. (2) Beryllium-copper and similar alloys are evidently not a hazard in the usual solid forms and processing; however, incorrect melting or pickling, which may produce harmful beryllium compounds, could conceivably cause trouble. (3) *There seems to be no real hazard attendant on the fabrication and use of industrial alloys containing beryllium.*

In discussions of beryllium poisoning the term "beryllium industry" should not be applied to include the alloy fabricators, for the amount of beryllium in their product is small (less than 2%) and is present in the apparently harmless metallic form. The real culprit in every poisoning case appears to have been some *compound* of beryllium, rather than the alloyed material.

"Good Enough is the Best"

Harry McQuaid dedicated Stevens' new Peirce Metals Laboratory with an appropriate lecture relating good design and common sense to materials selection. His motto "Good Enough is the Best" ought to be framed and placed in front of every engineer working with materials. Economics, he reminds us, is always more important than just quality.

Economic Madness

Professor Eugene Rochow of silicones fame, when recently awarded the Leo H. Baekeland Award of the N. J. Section of the American Chemical Society, discoursed philosophically on the way we waste the world's materials. According to the New York *Times:*

> *"he disapproves of the way automobiles are sold. Too much valuable metal is locked up in bodies, engines and chassis. He wonders why automobile manufacturers do not lend the metal in a car to a purchaser on a deposit basis. To sell the metal outright and rely on a haphazard system of collecting junk to return it as scrap is to him economic madness."*

This remarkable statement is simply glittering with brilliant facets of truth. Anyone who has had recent business with an automobile dealer must indeed "disapprove of the way automobiles are sold." And then, speaking of "valuable metal locked up in bodies, engines and chassis," breathes (or, rather, "fumes") there the man who hasn't locked up that valuable piece of metal, the car key, inside his car with the doors automatically and securely sealed against him, while he wonders by what magic he will resolve this dilemma?

Again, if the automobile manufacturers don't lend the purchasers *something* soon, there won't be any deposits on any basis, with car prices where they are. And as for "economic madness," we know dozens of people who have used Professor Rochow's exact words to describe the transaction whereby a man parts with $2,000 and up in return for something that once cost him half that, and with the radio and heater included, too.

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Volume 29

January—June 1949, Inclusive

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June
1949

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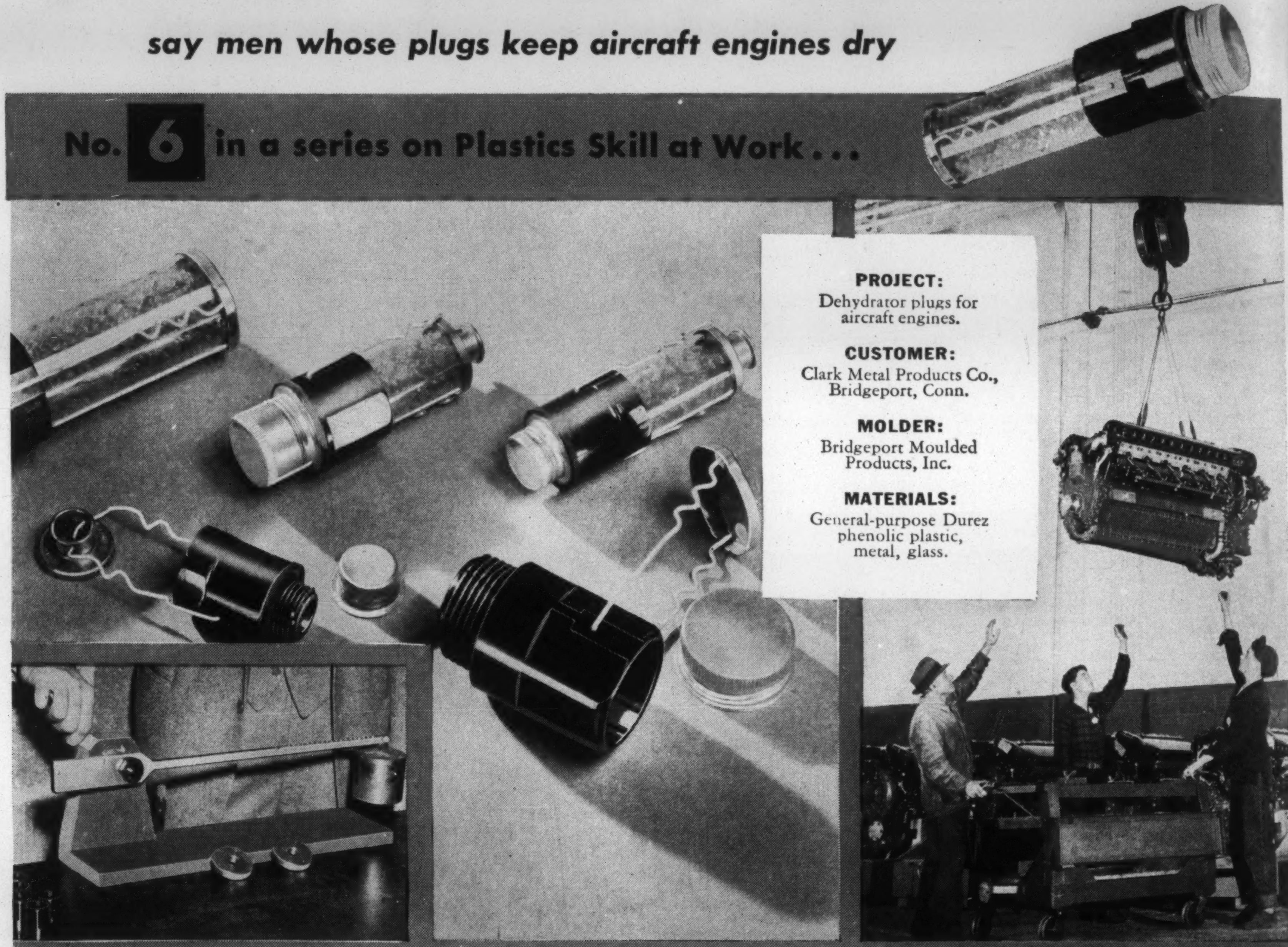

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Dehydrator plugs for aircraft engines.

CUSTOMER:
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MOLDER:
Bridgeport Moulded Products, Inc.

MATERIALS:
General-purpose Durez phenolic plastic, metal, glass.

Low-cost Durez plastic material passes both torque (illustrated) and water-vapor tests . . . make these dehydrator plug assemblies cost less . . . serve better.

Internal parts of aircraft engines are kept rust-free during world-wide shipment and in storage by silica gel crystals contained in the tubes.

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